COAL AGE

JULY, 1959

A McGRAW-HILL PUBLICATION

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THE MINING GUIDEBOOK

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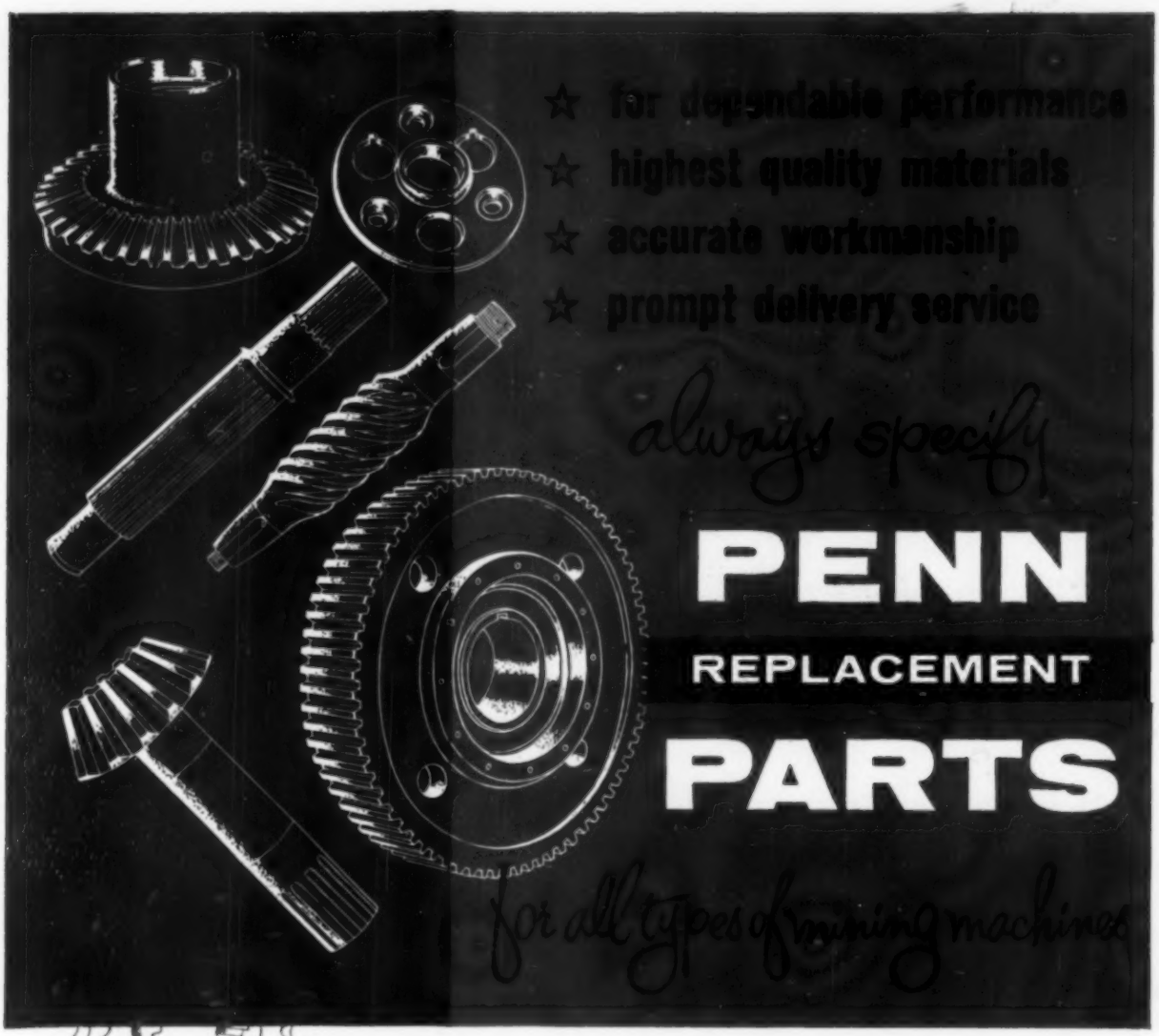

Penn Machine's modern facilities, years of engineering experience, highly skilled personnel and the use of finest materials, assure you of replacement gears, sprockets, shafts, bronze castings and specially designed parts that meet your most exacting requirements. Shipments made daily by our own trucks, rail, motor freight, and air express. Write, wire or phone us for prompt service.

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B.F.Goodrich

Mine gets added safety, no spillage with flexible, fire-resisting belt

THERE's no fuel for fire in the rubber of that conveyor belt. It will not support combustion or spread fire because it's a B.F.Goodrich belt made with fire-resisting rubber.

The special rubber used in this B.F.Goodrich belt also has high resistance to impact, abrasion, oil, grease, tearing, cutting, gouging and even mildew attack. As a result, a B.F.Goodrich belt made with fire-resisting rubber can be expected to equal—or surpass—the long service records made by other B.F.Goodrich Caricoal belts in underground mines.

Natural troughing is the reason why this B.F.Goodrich belt works well on a rope conveyor, and so lasts longer, reduces coal-handling costs. Because it's so flexible, it holds its cupped shape whether empty, lightly or fully loaded.

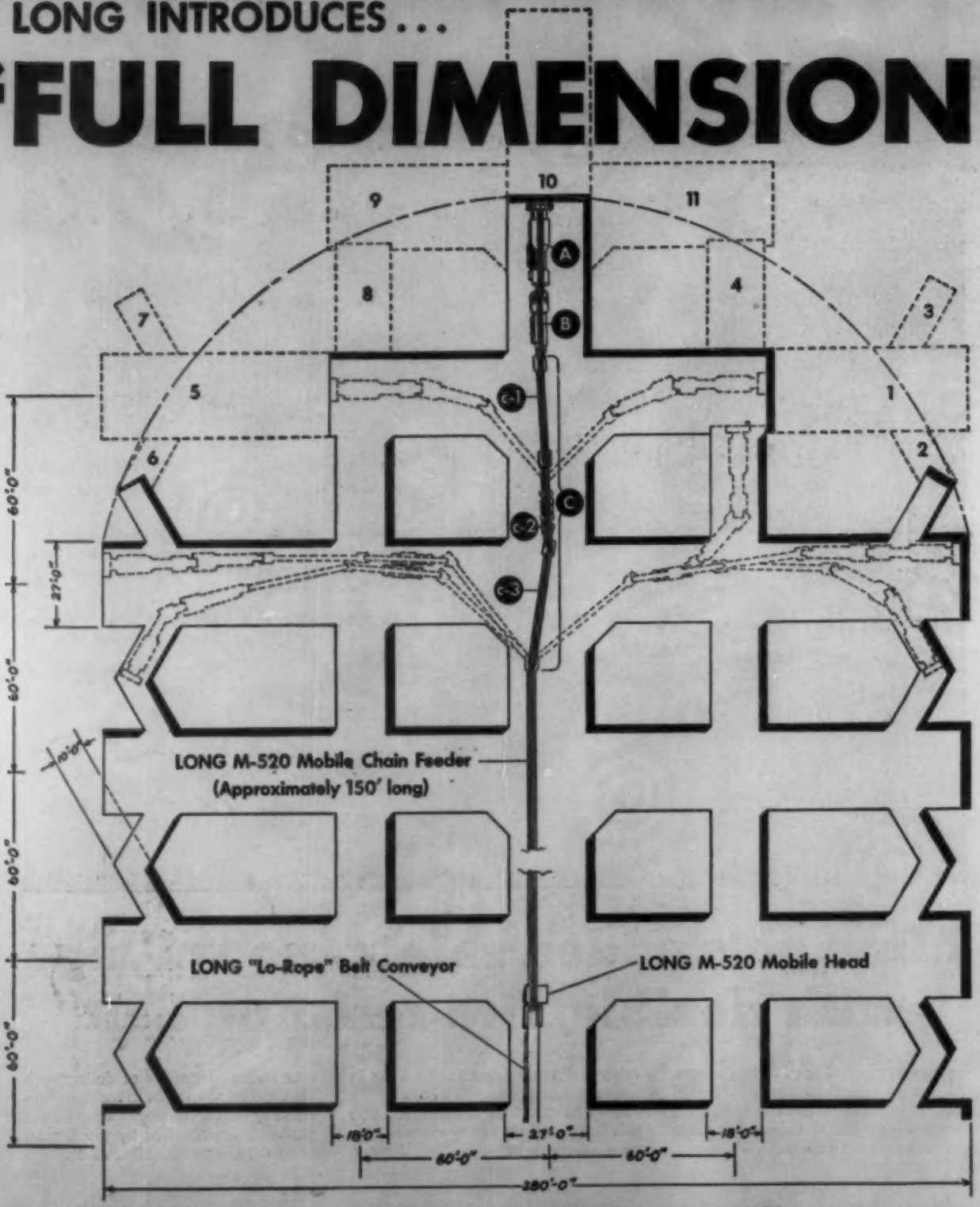
In states where ventilation stoppings are required if fire-resisting belts are *not* used, B.F.Goodrich fire-resisting belts eliminate costly protective walls, save mines thousands of dollars each year. B.F.Goodrich belts made of fire-resisting rubber have been accepted for listing as fire-resistant by the Bureau of Mines (Acceptance No. 28-6).

Before you buy another conveyor belt, look into the cost-cutting advantages and safety you can get with a B.F.Goodrich fire-resisting belt. Your B.F.Goodrich distributor can give you full details, or write *B.F.Goodrich Industrial Products Company, Dept. M-627, Akron 18, Ohio.*

B.F.Goodrich *industrial products*

LONG INTRODUCES . . .

"FULL DIMENSION"



Coal is mined by a continuous mining machine followed by a LONG 188 Loader. Behind the loader is the three-unit mobile bridge, which feeds on a mobile chain feeder approximately 100-150 feet long. Coal is moved from the mobile chain feeder to a LONG "LO-ROPE" Belt Conveyor, which may be driven by a mobile crawler mounted head section and which is equipped with a "HY-WINDER" belt winding station.

Extensibility of the "FULL DIMENSION" Conveyor System during operation is provided by the movement of the second Piggyback on the mobile chain feeder a distance of up to 150 feet, plus the movement of the first Piggyback on the mobile bridge carrier a distance up to 20 feet. Extensions or retractions of the belt conveyor are made at breakthrough intervals, usually 50 or 60 feet.

Equipment Designation (See Diagram)	Effective Length
A. Continuous Mining Machine	30'0"
B. LONG 188-D Loader	22'0"
C. 3-Unit Mobile Bridge Includes:	
c-1 LONG PT-218 Piggyback Conveyor	32'2"
c-2 LONG Mobile Bridge Carrier	25'8"
c-3 LONG PT-218 Piggyback Conveyor	38'8"
Coal Trajectory From Miner (Not shown)	2'0"
Total Effective Length	**150' 6"**

I'MINING —THE FIRST AND ONLY

EXTENSIBLE CONVEYOR SYSTEM THAT OFFERS:

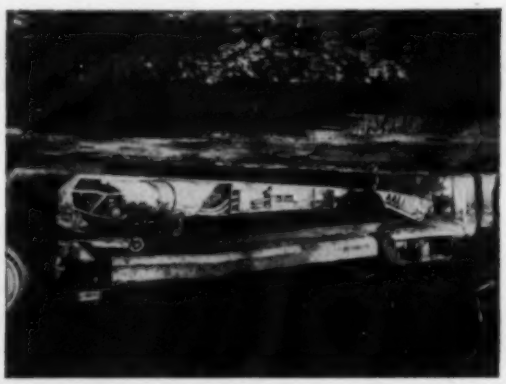
- **Multiple headings from one conveyor**
- **Recovery of pillars up to 100 feet wide**

The LONG "Full Dimension" Extensible Conveyor System offers higher capacity conveyor mining with all the flexibility of shuttle car haulage. Because of its long articulated reach and extensibility, this new system can be applied to almost any normal mining plan. The example on the opposite page is but one of many which can be used practicably.

Advantages of "FULL DIMENSION" MINING which have been demonstrated in many months of development and experimental use include:

- Continuous three-shift operation with virtually no delays for transportation.
- 67% increase in production per face man over a six-month period.
- Belt extensions are made, using the exclusive "HY-WINDER", at 60-foot intervals in approximately 15 minutes.
- Each extension (in 48" coal) permits the mining of 1500 tons with no delays except for repositioning the continuous mining machine.
- Deeper rooms and/or fewer belt moves with practical room transportation distance of 1000 feet or more.
- Dramatically improved housekeeping on the section with no constant movement of mobile machinery.
- Improved ventilation and safety because permanent stoppings are carried closer to the face with only the last open breakthrough being used for production haulage.
- Maximum crew cooperation resulting from the elimination of lifting, dragging, dodging, etc.
- Greater efficiency as there is more concentration of activity in a single working face for longer periods of time.
- Important safety advantages in improved roof support result from not having to keep open multiple haulways beyond the last open breakthrough.
- No wait whatsoever for transportation (except the 15 minutes required at each 1500 ton interval).

The "HY-WINDER" provides mechanical assistance in extending or retracting the belt conveyor. An extension requiring 15 minutes provides reach sufficient to mine over 1500 tons. (See diagram at left.)

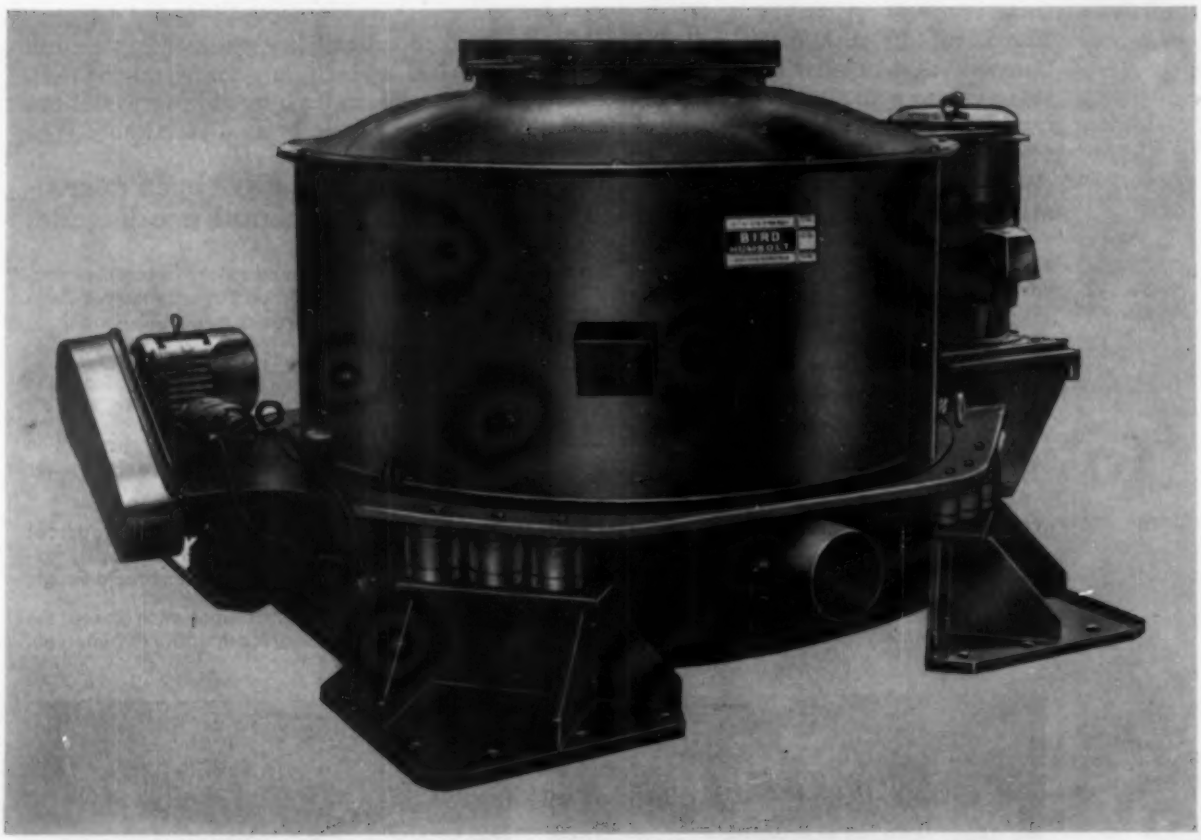


The three-unit mobile bridge, an exclusive LONG development, is highly mobile and maneuverable. It provides articulated reach up to 150 feet during full continuous conveyor operation.

Write for details or a demonstration

The LONG Company
Oak Hill, W. Va.

NOW, YOU CAN DEWATER *STOKER SIZE* COAL CENTRIFUGALLY!



The *Bird-Humboldt* Centrifugal Coal Dryer gets the surface moisture of 1" x ¼" coal down to 2½% or less — low enough to avoid all freezing in the cars.

The *Bird-Humboldt* does the job *without breaking up the coal*. Screen analyses prove that degradation is negligible.

The *Bird-Humboldt* dewaters the coal just as it comes from the vibrating screens, at a cost of *five cents or less per ton*, including write-off. Compare this with the cost of thermal drying which may run as high as 50¢ a ton.

New Bulletin tells why. For the complete story on this revolutionary, money-saving development, ask us to mail you a copy.

BIRD-HUMBOLDT *Centrifugal* COAL DRYER

BIRD
MACHINE COMPANY

SOUTH WALPOLE, MASSACHUSETTS

Regional Offices:

EVANSTON, ILLINOIS WALNUT CREEK, CAL. ATLANTA 9, GEORGIA

This Month in COAL AGE

JULY 1959

Features This Month:

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Moss No. 3: Clinchfield's Bid For World's Largest Mine ..... p 72

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Anthracite Takes Lead In Making Chemicals Directly From Coal ... p 98

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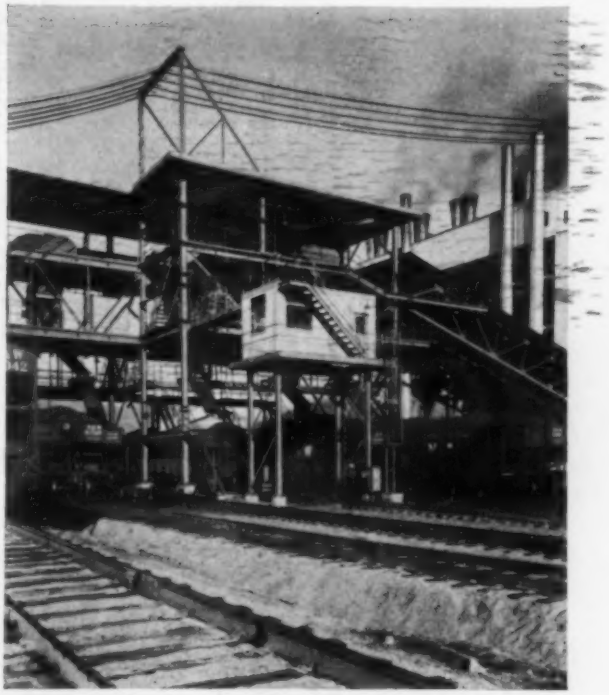
► Deep Mining

Moss No. 3: Clinchfield's Bid For World's Largest Mine ..... p 72

A. E. Flowers, Associate Editor, *Coal Age*

Production target for end of year is 22,000 tons of clean coal per day from $30,000,000 operation now producing 15,000 tons in two-shift mining. Specially designed equipment enables section crews to mine up to 1,500 tons per shift from 10- to 18-ft seam. Coal travels on 36- and 48-in belts from four portals to two railroad-car loading centers at the mine from which it is hauled 8 mi to the preparation plant.

Of Prime Interest—The mining plan; details of new-type belt feeder; how an expediter serves as mine nerve center.



► Preparation

Automation Keys Two-Stage Precision Washing at Moss No. 3 ..... p 80

A. E. Flowers, Associate Editor, *Coal Age*

One man in the main control room has at his finger tips control of 90% of the 1,500-tph plant. Coarse coal is cleaned in Link-Belt's new tank-type heavy-media vessels and the fine coal on Deister twin-deck tables in four parallel coarse-coal and fine-coal circuits. Ultrafines are recovered by froth flotation. Nucleonic density controls on the heavy-media washers assure consistently high quality of washed coal.

Extras—How the nucleonic density control works; how special materials cut maintenance; pneumatic unloading and handling of magnetite; pushbutton car handling with electro-pneumatic car retarders.

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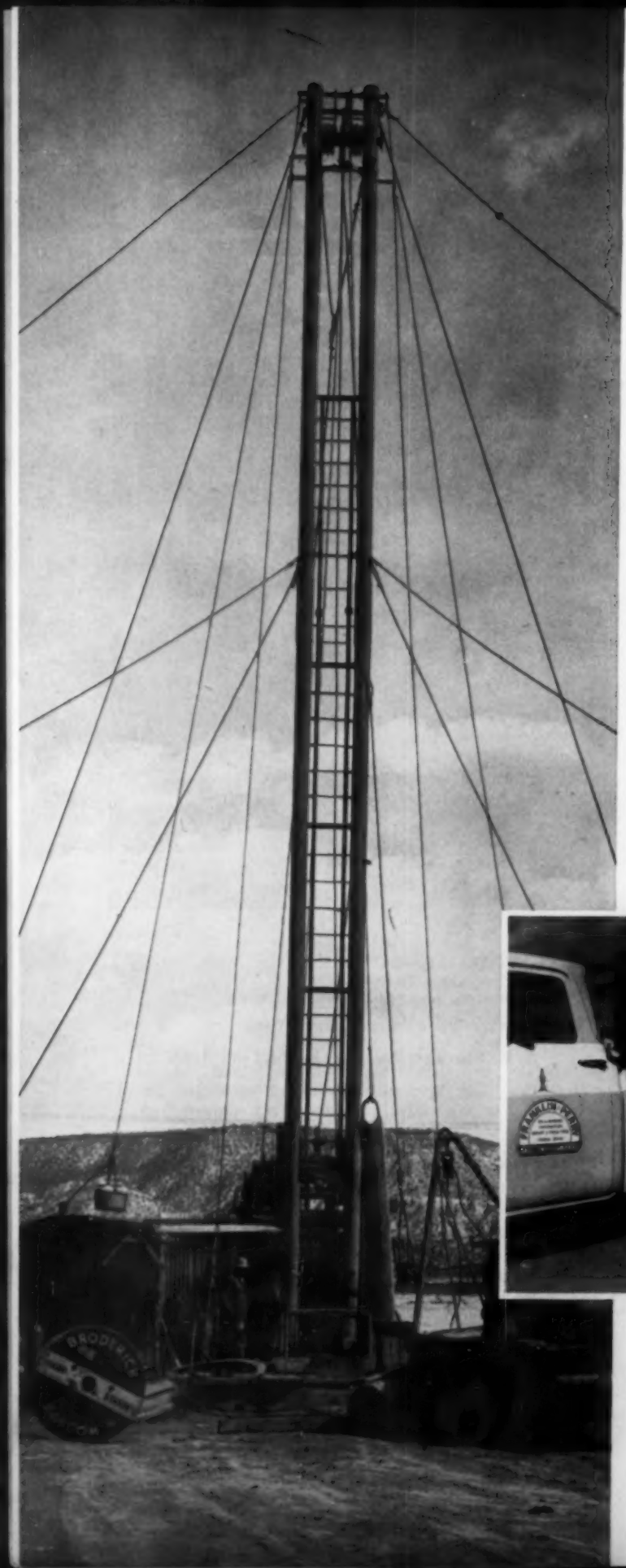


Yellow Strand BRODRIL drills

URANIUM ESCAPE SHAFTS

To punch 4′ holes ¼-mile down into the largest uranium field in the world, Franklin & Perry Drilling Company, Ozona, Texas, put Yellow Strand BRODRIL to test. BRODRIL carries a 24″ spud to churn through the initial hole. Then it handles an 8,000 lb., 48″ reamer to finish drilling the giant-size shaft that is used for escape and vent.

1″ 6 x 21 left lay BRODRIL fiber core cable tool line is used on the spudder, and ⅞″ 6 x 7 Yellow Strand fiber core is used for the sand line.

"Our BRODRIL lines wear longer under the severe pressure, shock, and jarring pull-down than any other rope we've used," says E. D. Strickland, job superintendent.

Tell your B & B representative to show you how the high abrasion resistance, resiliency, specially fortified fiber core and long-lasting lubrication of Yellow Strand BRODRIL can help hit the pay zone faster! Broderick & Bascom Rope Co., 4203 Union Blvd., St. Louis 15, Mo.

Yellow Strand®

WIRE ROPE SLINGS CLIPS

► Coal Chemicals

Anthracite Takes Lead in Making Chemicals Directly from Coal ..... *p 98*

In the proposed formation of Dynamics Reading Chemicals, Inc., Philadelphia & Reading and General Dynamics have moved the direct manufacture of coal chemicals closer to commercial reality. Plans call for building a $100 million anthracite-based plant near Pottsville, Pa. Process economy of the three-unit integrated plant is the basis for its expected commercial success. Another competitive advantage: About 40% of U. S. industrial consumption of chemicals takes place within 300 mi of the plant's location.

Worth Noting—Map defining marketing range; three-unit process diagram; backyard 300-million ton supply of plant's silt-and-refuse raw material.

► Strip Mining

Million Tons Per Year: Goal for 70-Yd Coal Chief ..... *p 108*

Ohio's largest coal stripper moves 1,800,000 cu yd of overburden per month to expose 80,000 tons of coal at Simco Peabody's Coshocton mine. Overburden, drilled with a vertical rotary dry-type unit, is broken with prepacked ammonium nitrate blasting agent. A fleet of 51-ton trucks carries coal 3 mi over company roads to Columbus & Southern Ohio Electric Co.'s new Conesville power plant.

Bonus—How electric engine heaters simplify cold-weather starting.

(Continued on p 9)

This Month in COAL

CONTINUED SLOW—In contrast to the high level of activity in other segments of the economy bituminous continued to dawdle in the opening month of the third quarter. Having wound up the first half with a gain of around 6.2% production continued to stay near or only slightly above the 8-million-a-week line, though an improvement is looked for by September and following it a relatively good fourth quarter with a rate of around 9 million a week. No great increase in exports is expected, but there should be some replenishment of stockpiles in addition to a rise in demand for current consumption.

MORE LOSSES FOR ANTHRACITE—Following the pattern of several years, in spite of the temporary fillup resulting from last winter's cold spell, anthracite continued to lose tonnage in the first half of 1958. Barring another cold period next winter the decline will continue at about the present rate and the industry will wind up the year another 1 to 1½ million off—not much in some respects but still another drop.

DOWN FOR FUEL RATES—One perhaps unappreciated factor in the results so far in 1958, particularly in bituminous, is the continued drop in fuel rates. What might be termed the normal reduction is being achieved in power generation but something akin to a breakthrough is being registered in the coke rate. In fact there is good reason to believe that metallurgical consumption may be cut as much as 10% over what it otherwise would have been in 1958 as a result of more-efficient processing and use of raw materials by the steel industry. The old rule of thumb calling for 1 ton of coal per ton of steel may have to be modified in the relatively near future.

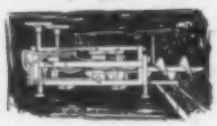
TEST COMING UP?—Scuttlebutt current at the time this was written had it that the first court test of the "protective wage clause" in the last agreement was imminent. You could get bets both ways—either that it would stand up or that it would eventually be knocked out by the Supreme Court. Meanwhile there were reports that a substantial number of holdouts would sign, and also signs that those remaining outside were organizing to make their action pay off for them through special sales setups and other steps. Indications are that it will be a long time before the problems raised by this departure from past practice will be settled.

REORGANIZATION SCORE SHEET—It was counted in June as a foregone conclusion that one of the organizations to be taken into the National Coal Association under the new reorganization plan would be the American Coal Sales Association. Others proposed for consolidation are Bituminous Coal Institute, Bituminous Coal Research, Coal Exporters Association, Coal Producers Committee for Smoke Abatement, Automatic Solid Fuels Equipment and Fuels Research be the American Coal Sales Association. Others pro-Council. It is expected that all will join up.

IF YOU'RE FIGHTING RISING PRODUCTION COSTS

IN THE PIT

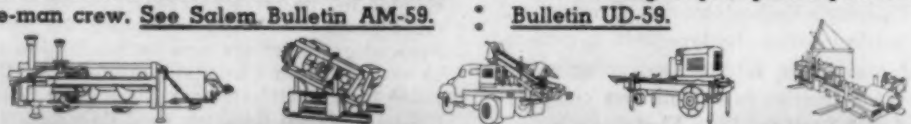
High-production, self-moving, McCarthy coal recovery drills cost less to buy and less to operate. Only a two-man crew required. No tractor needed. Augered coal costs less. See Salem Bulletin ST-59.



OR UNDERGROUND

Underground coal recovery drill has separate power unit. Turns within own length. Drills to horizontal depth of 100 feet. Five-foot augers are recovered from first hole while second hole is drilled. Just a three-man crew. See Salem Bulletin AM-59.

Compact, fast, rugged unit drives air holes, manways, storage holes and conveyor runways ten times as fast as conventional methods. Drills from –45° to straight up. Separate power unit. See Salem Bulletin UD-59.



THE **SALEM** TOOL COMPANY

763 S. ELLSWORTH AVE. • SALEM, OHIO, U.S.A.

►Management Development

How to Make Better Decisions . . . . . *p 114*

Harold L. Durrett, Personnel Manager, Hanna Coal Co., Moundsville, W. Va.

Through study and practice of the basic steps in decision-making, every supervisor can improve his skill in problem-solving. The basic steps are: Recognizing and defining the problem, finding facts, identifying alternatives, and choosing the alternative or combination of alternatives which appears best in terms of a predetermined goal. Effective decisions require good timing and sincere effort to minimize biases and prejudices. Elements are the same, but accelerated, in making quick decisions.

Plus Features—The decision-making process applied . . . choose a problem of your own . . . try this specific case.

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This Month in Mining Practice

CAPACITY WITH LOWNESS—The diversity in types of continuous miners still being introduced points up once again the spread in operating conditions that must be provided for in designing mining equipment. No one type has a monopoly, witness the fact that new introductions include boring units and units with swinging heads equipped with rotary or milling-type mining elements. But whatever the design the coal operator now is benefiting more and more from machines for coal under 36 in, both continuous and conventional, and from major increases in capacity—8 to 10 tpm rated, for example, for new loaders only 24 in high. Incidentally, as rated capacities climb more and more emphasis is being placed on the development of auxiliaries with equal ratings.

EXTENDED LIMITS—The Kolbe wheel excavator tour of June 17 re-emphasized the importance of auxiliaries in strip mining also—though a machine of the size and cost and with the performance of the new unit perhaps more deserves the term of a primary production unit. But whatever the terminology it is a fact that equipment to help or accompany the main shovel or dragline is one of the big keys to extending the range of coal recovery at a practicable cost. Otherwise, the limits on stripping, even with the help of bigger longer-range shovels and draglines, would be much lower than they presently are.

PREMIX OR ON-THE-JOB?—The process of changing underground mining over to nonflammable hydraulic fluids is now under way. How fast the change will take place still is a matter for the future, along with answers to questions that have or will come up. One is whether to buy ready-mixed or do the mixing at the mine. This means balancing economy against the possibility of a poor job with all its consequences.

ELECTRIC WHEELS—Other things being equal putting the driving mechanisms in the wheels of a vehicle can simplify design, promote efficiency and reduce maintenance. This is the reason for the present emphasis on electric-wheel design, since the electric motor is a natural for the application. Look, therefore, for the electric wheel on such items as shuttle cars in the relatively near future, in addition to haulers, tractors and other vehicles in surface operations.

DELAYS FOR STUMPS—Getting out those last small stumps where crushing cannot be relied upon is a bothersome and somewhat hazardous and costly operation. New ideas for minimizing some of the handicaps include millisecond-delay detonators to permt safer, more-convenient shooting where several stumps must be taken care of at one time.

REPORT ON HYDRAULIC MINING—Though there are difficulties and drawbacks (see for example, "Coal Industry of the U.S.S.R.," now available from the Foreign Languages Publishing House, Moscow, for example) plans are now going ahead for hydraulic-mining trials in coal in the U. S.

EXPANDING in SERVICES and PRODUCTS

For the Mining Industries

National Mine Service Company

Seven major products distributed and serviced exclusively by National Mine

National Mine TorKar

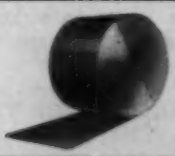
With operation based on a single prime-mover and torque converter, AC, DC and Diesel-Powered TorKars are establishing new standards of shuttle car performance, with sharply reduced maintenance.

Greensburg Locomotives

From National Mine's Greensburg Division, a complete range of Monitor Type Storage Battery and Diesel Locomotives from 2 to 15 tons. More pulling power per ton, higher efficiency for every invested dollar.

Wheat National Electric Cap Lamp

A major advance in better light for the miner, incorporating significant new developments in battery, bulb and fingertip focussing—resulting in better light, greater utility, better service.



Scandura Belting

Stronger, lighter and more durable, fire-resistant P.V.C. Scandura is best for the long haul; best for extensibles! More productive because it stays on the job without expensive repair.

Clarkson Redbird Conveyor Chains

The leader in conveyor chain performance, with balanced construction providing longer, trouble-free service. Welded flight assembly lessens wear and strain, eliminates need for adjustment. A Clarkson Division product.

Hayden Belt Fastening Equipment

Using Tenex Hooks, the small, easily portable 17½-lb. Hayden "Autoclip" makes stronger conveyor belt splices in less time on the job and in limited working space. Material cost 25% lower, labor cost 75% lower—plus economies of reduced downtime.

Marietta Continuous Miner

This is a rugged, powerful, caterpillar-mounted, boring-type continuous mining machine of proven high capacity in coal and non-metallic mining—built by National Mine's Clarkson Division.

NATIONAL MINE SERVICE COMPANY

Koppers Building · Pittsburgh 19, Pa.

National Mine Service (Canada) Limited, Elliot Lake, Ontario

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The Coal Commentator

Value for You

The fatness of this issue of Coal Age reflects the fact that it is designed to do a double job. In addition to presenting the regular fare, including the story of one of the country's major new underground properties, this issue includes the Coal Age Mining Guidebook, previously published separately.

If you had to buy the Mining Guidebook as a regular book it probably would cost you at least $10. And, you get your usual *Coal Age* issue at the same low price.

Your bargain is a big one from another angle. The Mining Guidebook, with a lot of new material in it this year, is the only place you can find in one spot the basic principles on which good mining must rest supplemented by the latest in mining and equipment developments.

Check your Guidebook carefully and keep it handy. It has real value for you.

Critical Link

The shuttle car remains a major factor in face transportation and will continue as such in the future—at least as far as one can see ahead. Consequently the problem of handling the transfer of its load without loss of time also remains a critical one, since a delay in this is a delay—repeated many, many times a day—all along the line.

Along with ability to store sufficient coal to let the shuttle car discharge promptly at full capacity the transfer unit must be reasonably portable. Both considerations become more important as the height of the coal decreases. Growing appreciation of the need for better facilities at the transfer point is now leading to the introduction of special equipment for both thick and thin coal, all offering a significant saving in time.

All the problems, however, have not yet been licked, particularly in thin coal, but the progress to date is a good indication that operators will have an increasing number of machines with greatly increased effectiveness to draw on in the future.

Double Objective

Gas and roof—not necessarily in that order—continue as two of coal's big operating headaches. Perhaps both of them may be alleviated in the future by the same tool—the drill.

Drilling from the surface to accomplish the double objective of gluing roof members together and draining off gas already have been suggested as a result of work already done. The permeability of the strata is one of the factors in roof gluing. In the case of methane drainage a big unknown, in spite of the years of experience, is how the gas is held in the coal and adjacent strata.

It is within the realm of possibility that these and other problems will be solved and that these developments may join others now being perfected or yet to be thought of in coal's progress to the ultimate in safe, low-cost production.

Real Target

Joseph R. Forsythe, the genial and able manager of *Keystone Coal Buyers Manual*, an affiliate of *Coal Age*, quite recently touched upon what should be but isn't always a guiding principle in coal merchandising. At the time he was discussing ways and means of doing a better job in the "Other Industrial" field where one of coal's biggest opportunities lies in the days to come.

Coal's other two big outlets, as is well known, are electrical utilities and steel. In both of these, however, though merchandising policy and procedure are critical, they are not as critical as in "Other Industrial."

The Forsythe recipe? "Sell against oil and gas, using the new firing and handling equipment and techniques now available. That's where the real opportunity for building business lies—not in trying to shift tonnage already on the books."

Not Impossible

Theoretically longwall should result in the most-efficient mining of all the known systems. Practically, in the U.S., longwall—and longface—have had hard sledding and have not as yet made any appreciable dent in room-and-pillar.

Is there a possibility of a change? The next year or two probably will tell, though perhaps not. But progress has been made on two of the critical fronts. The first is, of course, a practical, positive system of roof support. The second is a mining machine less subject to delays than most of those hitherto employed, and thus more able to contribute to high output per face and per man.

Room-and-pillar will, of course, continue as the U. S. mainstay for a long time to come. At the same time new improvements may bring a longwall into the picture in this country on a significant scale. It's not impossible.

These special steels that do more put money in the bank for you

Today's mining equipment built with USS High Strength Steel, super-strong USS "T-1" Steel or USS Stainless Steel is the biggest, brawniest and most durable ever made. It's true that these steels cost more per pound in most cases, but fewer pounds are needed. They cut dead weight, increase payload, boost service life, reduce downtime and save operating dollars. Every dollar you spend for these stronger, tougher, more abrasion-resistant steels puts money in the bank. For example, "T-1" Steel bucket teeth have outlasted other teeth from five to 10 times . . . and stainless steel filter screens have lasted 50 times as long as the material they replaced.

USS, COR-TEN, MAN-TEN, TRI-TEN and "T-1" are registered trademarks

Here are the USS Steels that do more:

USS MAN-TEN Steel—High strength with abrasion resistance and economy. (Minimum yield point 50,000 psi)

USS COR-TEN Steel—High strength with superior atmospheric corrosion resistance. (Minimum yield point 50,000 psi)

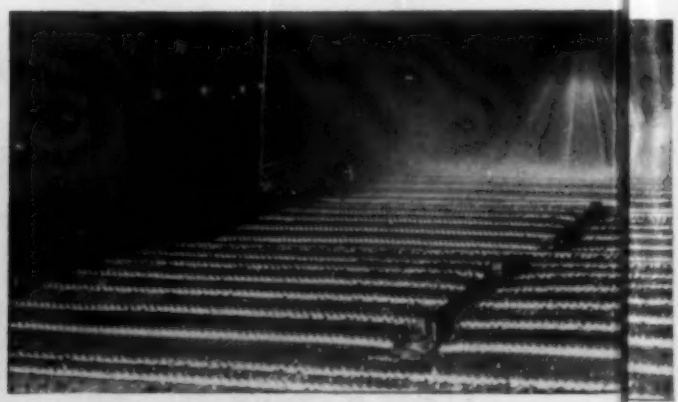
USS TRI-TEN Steel—High strength with toughness, weldability and abrasion resistance. (Minimum yield point 50,000 psi)

USS "T-1" Steel—Super strength with impact abrasion resistance, weldability and toughness. (Minimum yield strength 100,000 psi)

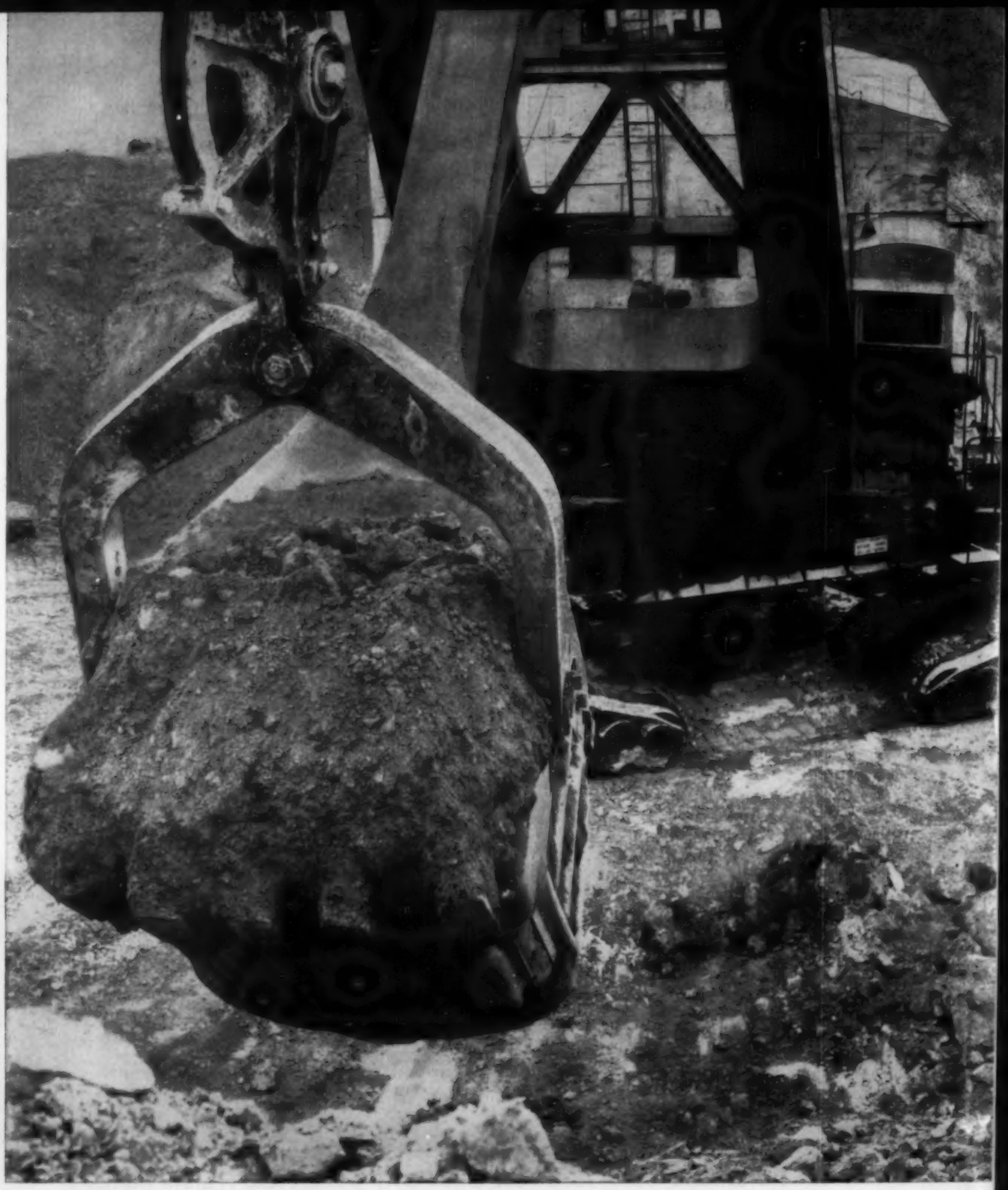
USS STAINLESS Steel—High resistance to corrosion, elevated temperature service and abrasion.

Each of these USS Steels is superior for certain applications. Our metallurgists will help you choose the best steel for your job. Contact our nearest sales office or United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

High Strength Steels in Alaska. Located 100 miles out in the bush, with the responsibility of mining 75,000 tons of coal annually, this earth-moving equipment hacks, dozes, hauls and scoops both coal and overburden the year round. Bulldozer blades and shovel buckets must be tough and independent—able to withstand extensive periods of 30° below zero weather. High strength steels stand up under this brutal punishment—keep production moving.



Stainless Steel vibrating screen handles more than 400,000 tons of run-of-mine coal at Island Creek Coal Co., Holden, W. Va. Present unit has lasted more than a year. Cost of screen runs about 0.3 cents per ton of coal processed. The same story of low-cost operation holds true at other mines where stainless steel is doing yeoman duty. Stainless Steel coal chutes eliminate the build-up of coal caused by week-end corrosion of the old chutes. Service life is greatly increased. Stainless vacuum filter screens remain in service a year against only a few weeks for previous screens.



5 times the life from USS "T-1" Steel. This 18-cu.-yd. shovel bucket has lips and teeth made from USS "T-1" Steel. The old teeth made of mild steel lasted about 80 hours. Another alloy lasted 160 hours. Now, with "T-1" Steel, they get a whopping 400 hours minimum. USS "T-1" Steel's outstanding resistance to impact abrasion made the difference and resulted in large savings. The teeth cost about $100 apiece. Now most of this is saved by the drastic cut in maintenance costs.

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American Steel & Wire – Cleveland
Columbia-Geneva Steel – San Francisco
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United States Steel Supply – Steel Service Centers
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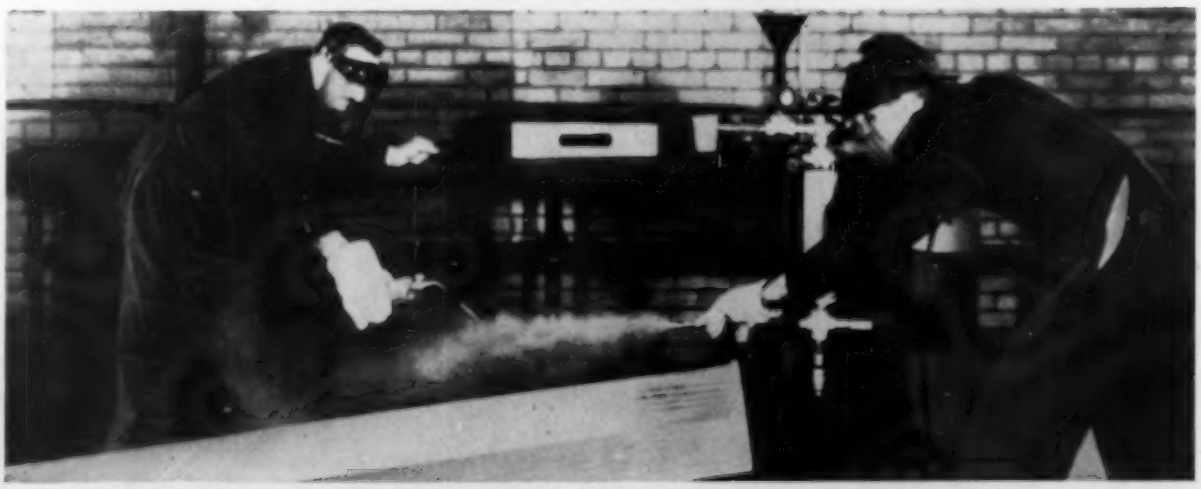
United States Steel

USS

First low-cost

Flame tests prove fire-resistant properties of this hydraulic oil

Dramatic photo above shows flammability of conventional hydraulic oil.



Not so dramatic, but . . . see how Shell 3XF Mine Fluid resists flame.

Photos courtesy: U. S. Bureau of Mines

SHELL 3XF

fire-resistant mine fluid

Shell 3XF Mine Fluid has been tested by U. S. Bureau of Mines and is now in use

Now—for the first time in mining history—an inexpensive, fire-resistant emulsion-type hydraulic fluid is available for mine equipment use—Shell 3XF Mine Fluid.

NO MAJOR MODIFICATION OF EQUIPMENT IS NECESSARY—Shell 3XF* is a direct replacement for ordinary hydraulic oils now in service.

CONVENIENT TO USE—Shell 3XF Mine Fluid, furnished as a concentrate, is mixed with water to prepare the emulsion *at the mine location*.

PROOF OF ITS FIRE-RESISTANT QUALITIES—In addition to recommending the use of fire-resistant hydraulic fluids in mining machinery, the Bureau of Mines has evaluated Shell 3XF Mine Fluid using test methods that determine fire-resistant properties, and accepted it for Mine evaluation, pending the establishment of a Bureau approval schedule.

FOR COMPLETE INFORMATION on Shell 3XF Mine Fluid, write or call Shell Oil Company, 50 West 50th Street, New York 20, New York, or 100 Bush Street, San Francisco 6, California. In Canada: Shell Oil Company of Canada, Limited, 505 University Avenue, Toronto 2, Ontario.

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A complete, pre-engineered, pre-fabricated HMS plant for profitable, premium coal production from first day of operation. Integrated design for rapid erection — and one man operation — even by inexperienced personnel. Answers ash reduction problems economically, profitably.

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For sharp separations where longer retention time is required in size range of 4 inch to approximately 10 mesh. Clean coal floats to the surface and overflows; sink material removed by airlift.

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Mixes coal-water slurry with reagents to condition coal particle surfaces when necessary before flotation. Available in Wemco-Fagergren type and propeller type.

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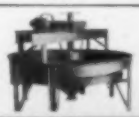
High capacity, low cost dewatering device for coal from ⅜ inch to 48 mesh. Also serves as classifier for slimes and fines, making sharp overflow separation at 35, 100 or other desired mesh size. An important use is for dewatering of wet screen underflows.



WEMCO HYDROSEPARATOR

Used for desliming fine coal ahead of flotation or tabling, and low-cost, efficient separation in minus 200 mesh range. Slimes overflow weir at low velocity. This prevents loss of desired plus 200 or finer mesh particles. Fine coal for flotation withdrawn from center of tank bottom.

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WEMCO DIAPHRAGM PUMP

Withdraws continuous volume from thickener or hydroseparator underflows. Useful for feeding pulps at constant rates. Slow speed, reliable and easy to maintain.

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New principle incorporates recessed impeller, continuous, open passage. Permits pumping of large solids in slurry without clogging or degradation and with minimum wear.

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FIELD REPORTS PROVE SUPERIOR PERFORMANCE OF NEW BOSTON BELTS

DIGEST OF PERFORMANCE FIGURES FOR 1296 BELTS*

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130% improvement in consistency of elongation

*Compared to belts previously manufactured

HERE'S WHAT DOES IT!

The startling figures above are a direct result of two major belt manufacturing advancements — both developed by, and exclusive with, Boston Woven Hose & Rubber Co.

ADVANCEMENT #1 **BALANCED BELT CONSTRUCTION** for the first time equalizes ply stress so that each ply pulls its full share of the load. **BBC** eliminates lazy plies. A BOSTON exclusive because only BOSTON can combine Electronic Tension Controls with Rotocure, the continuous method of vulcanization, which assures uniformity throughout the belt.

ADVANCEMENT #2 **DULON** markedly improves the aging characteristics of BOSTON belts. An exclusive BOSTON research development, the tough specially treated cover compound stays resilient longer . . . makes the belt much more resistant to abrasion, gouging, tearing and oxidation.

BALANCED BELT CONSTRUCTION plus **DULON** add up to longer belt life . . . less trouble in service . . . greater economy.

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DIV. OF AMERICAN BILTRITE RUBBER CO., INC.
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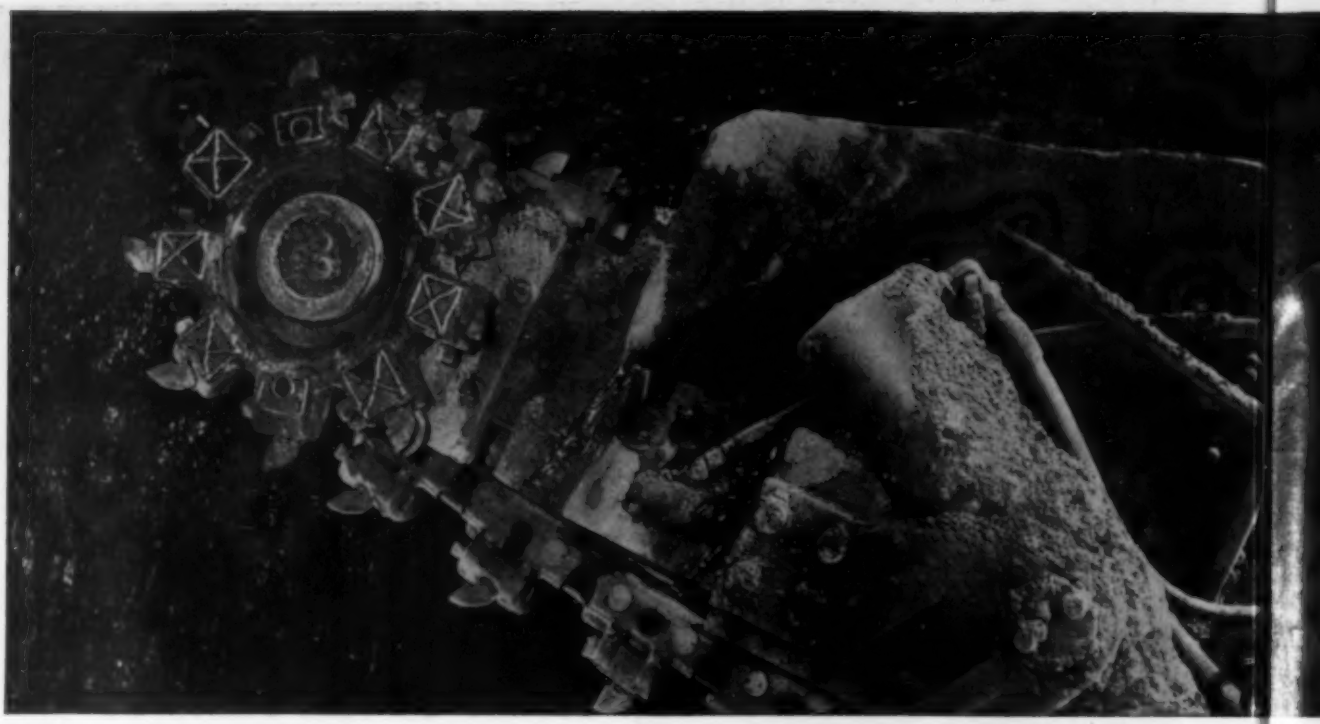

It's better to buy GOOD quality

Bits, bolts, belts and brattice are all made and sold by following certain economic laws. You can't pay a little and get a lot.

"If you deal with the lowest bidder, it is well to add something for the risk you run. And if you do that you will have enough to pay for something better."

John Ruskin

NO OTHER BIT INSURES PRODUCTION LIKE A KENNAMETAL BIT

The quality of carbide cutter bits often makes the difference between a $100,000 mining machine that is mining coal and one that is down for changing bits. Kennametal Bits are consistently high in quality to protect your investment by keeping expensive machines on production. Kennametal carbide quality is the result of rigid and complete process control.

For more than 13 years, Kennametal Engineers have been developing stronger, more efficient mining tool designs and you can look first to Kennametal for the latest advances.

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. . . than pay for POOR quality

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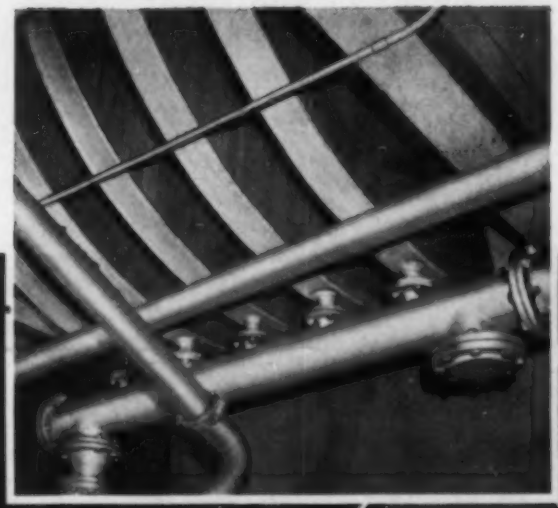
FINE COAL RECOVERY INSTALLATION

American Disc Filter



Underside of American Disc Type Filter illustrates separate disc compartments and common feed manifold.

American Disc Filter features extremely large filter area for the space occupied. Individually sectored discs permit cloth replacement with minimum downtime.

PAYS OFF AT VALLEY CAMP

with "hindered settling" feature

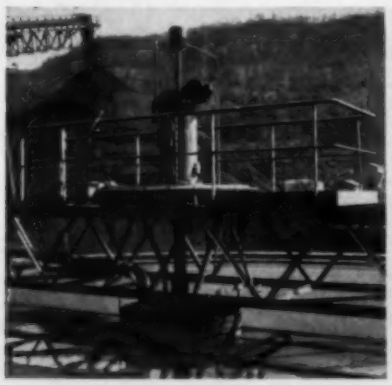
used with Dorr Thickener and Oliver Slurry Pump

At the Valley Camp Coal Company's #8 plant, Shrewsbury, West Virginia, 75 tpd of fine coal is recovered in this efficient installation. It is another excellent example of the industry's growing use of Dorr-Oliver equipment, tailored specifically to the needs of each individual job.

In flow sheet order, the equipment includes a 55′ dia. Dorr Type A Thickener. Underflow is handled by an Oliver ODS diaphragm-type Slurry Pump and an 8′ 6″ dia. vacuum disc American Filter.

Excellent coal recovery is due in large part to the effective solids retention characteristics of the American Filter, which normally shows less than 1% of solids in the filtrate. Contributing to this and to simplified operation is the "hindered settling" feature of the design. Feed is introduced at the bottom through a common manifold to separate compartments for each filter disc. This arrangement tends to prevent settling and in many cases avoids the need for mechanical agitation.

For information on the full range of Dorr-Oliver equipment for coal drying, cleaning or recovery, write Dorr-Oliver Incorporated, Stamford, Connecticut. Ask for Bulletin 7101.



Dorr Type A Thickener is a proved unit now widely used throughout industry. Feed at Valley Camp is chemically treated and overflow discharges to river.

Oliver ODS Slurry Pump handles underflow from Thickener. Diaphragm is actuated by vacuum or air pressure —no mechanical linkage required.

*American—Reg. T.M., U.S. Pat. Off.

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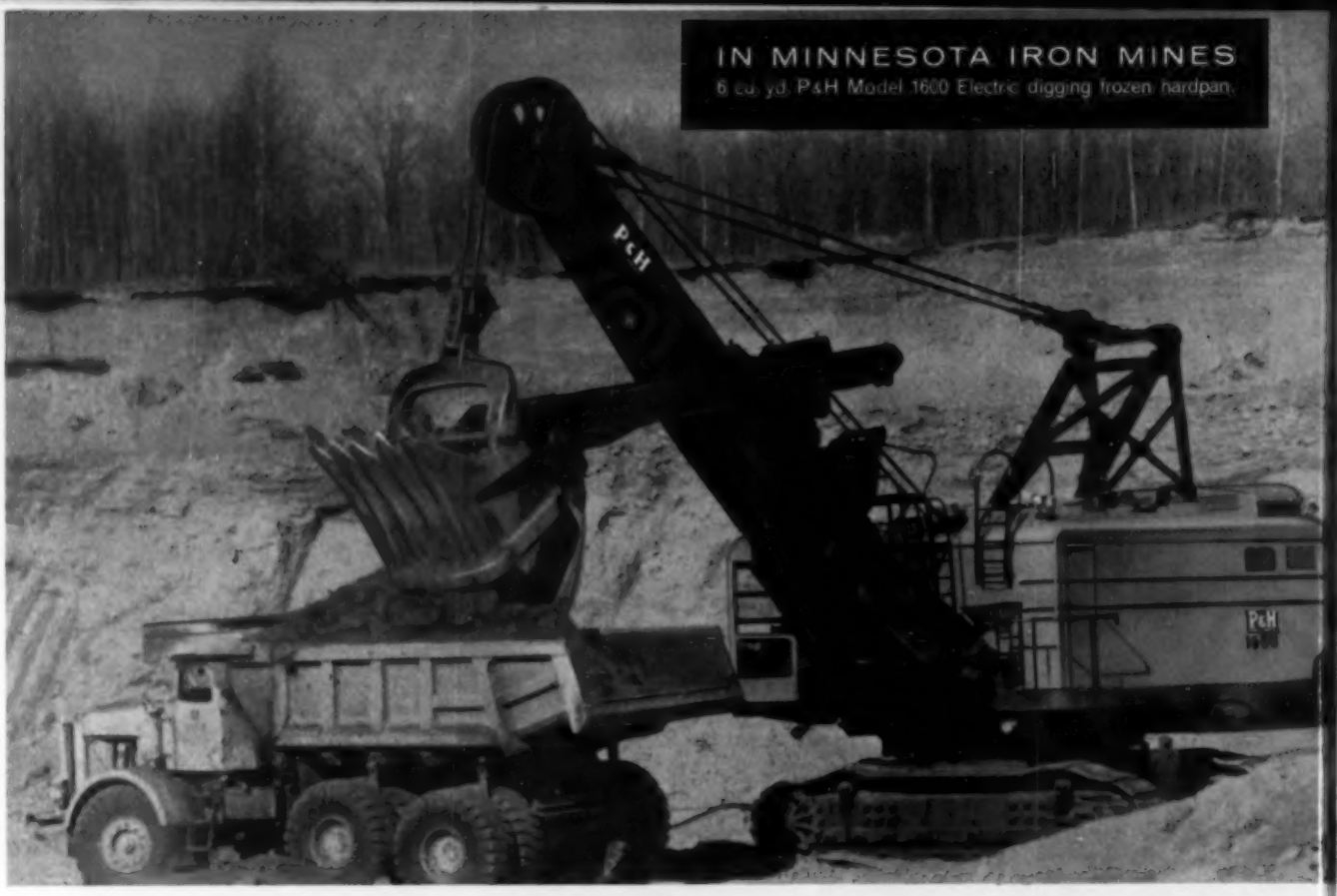

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Up to 30% higher bail pull—faster swing—exceptional physical strength of P&H welded construction—greater job availability all add up to as much as 10% more production, lower loading cost per ton and *more net profit* for owners of P&H Electric Mining Excavators on their hardest digging assignments.

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MAGNETORQUE' . . . the most productive digging motion drive known for electric excavators. This *patented* P&H drive electro-magnetically transmits full digging power from an A. C. hoist motor direct to the dipper without motor generator set conversion to D.C. current. It gives higher bail pull, better dipper fill factor and automatic impact protection to the digging machinery.

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In addition, with P&H—and only with P&H—do you get the service assurance of single source responsibility. P&H manufactures their own electrical as well as mechanical components—*designed specifically for electric excavator service.* Write Dept. 556, Harnischfeger Corporation Milwaukee 46, Wisconsin.

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Electric Excavators: 3½ through 10 yds.
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Milwaukee 46, Wisconsin

News Roundup

◀ **CLAIR PAYNE**, of Gorton Junior High School, Warwick, R. I., shows a pamphlet from her exhibit on the coal industry to Herbert Chadwick of New England Coal & Coke Co. The display, parts of which were supplied by the coal firm, won first place in competition with 462 entries in the Rhode Island State High School Science Fair. In the center of the exhibit is a cut-away coal shaft with scale-model tipple.

Education . . . A Vital Period

Coal companies and manufacturers offer scientific cooperation and award scholarships to promising students to help insure America's future.

AWARENESS OF THE TIMES indicates that education is on the lips and minds of Americans everywhere. The much used phrase, "education opens doors," still stands unchallenged. But it has come to mean more than ever today. Trained minds, especially in the sciences, are being recognized as increasingly vital if the United States is to maintain its lead over Russia in a race for superiority that appears to be entering the stretch drive.

In education, coal companies and industrial manufacturers are doing their parts to excite interest and further scholarship in science. Illustrative of this is the cooperation given by Eastern Gas & Fuel Associates to Miss Claire Payne, a junior high school student, who won first place in Rhode Island's statewide Science Fair for her exhibit, "Treasure Beneath Us." The exhibit, chosen over 462 other entries, featured a scale-model mine tipple and wheel house and a cutaway view of a coal shaft, an air shaft and the layers of topsoil, limestone, shale and coal seams.

Willing Aides—Representatives of New England Coal & Coke, an Eastern Gas subsidiary, cooperated fully with Miss Payne, supplying samples of various types of coal, miners' equipment, descriptive literature about the industry and enlarged photographs of mining operations and installations of the coal division. Another section displayed coal-chemical samples and had publications about the many coal derivatives.

Coal's Contribution – This company's contribution to science education is typical of the efforts made by many coal firms to help young people develop their minds along scientific lines. *Coal Age* has published numerous reports about scholarships provided by coal firms to promising students in highschools and colleges throughout the nation.

Most recent scholarship awards were made by the Princess Elkhorn Coal Div. of Princess Coals, Inc., to five Kentucky students, winners of its annual competition. Chosen were: Judith Dixon—four-year grant to Pikeville College; John Hill—four-year grant to study electrical engineering; Rodney Bussey—four-year grant to Berea College; and Roger Blair—four-year grant to University of Kentucky in civil engineering.

This brings to 73 the number of grants made to outstanding graduating seniors in Kentucky by the firm. Twelve students attended college during the past year with assistance from Princess Coals: four were at Pikeville College, one at Berea, another at Union College and five at University of Kentucky.

Others Join—More and more manufacturing firms are joining in awarding scholarships. Joy Mfg., for example, awards annually two four-year scholarships to employee's children who have excelled in their high school work as well as having participated in extra-curricular activities. Recently Joy announced that this year's scholarships would go to Daniel Ricketts of Pittsburgh, and Vernon W. Flinchbaugh II, of Franklin, Pa. Mr. Ricketts plans to enroll in the University of Dayton in electrical engineering and Mr. Flinchbaugh will go to Pennsylvania State University to study architectural engineering.

Industry's Stake – The importance of these company educational grants to the mining industry is made clear by a recent statement of James D. Forrester, dean of the College of Mines at the University of Arizona. Mr. Forrester has been urging high school graduates to consider careers in the mining industry. He explained that there is extreme difficulty in accommodating requests from mining firms for qualified engineers . . . "the opportunities for advancement of competent and qualified men are outstanding."

(*Continued on p 28*)

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MC-1 MINE CAR TRUCKS

NATIONAL CUSHIONING UNITS

every day, every year more and more mine cars and locomotives are equipped with

NATIONAL DEVICES

No matter whether you're considering the purchase of new mine cars or locomotives . . . or whether you're thinking of upgrading existing equipment *now* is the time to investigate the advantages of National devices.

For every day cost-conscious operators everywhere are switching over to National devices because they know they get more out of their equipment investment per workshift . . . per day . . . per year.

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NATIONAL MALLEABLE and STEEL CASTINGS COMPANY

Established 1868 *Cleveland 6, Ohio*

WILLISON AUTOMATIC COUPLERS · RUBBER CUSHIONED UNITS · NACO STEEL & NKC and SWIVEL HITCHINGS · MINE AND INDUSTRIAL CAR TRUCKS · NACO STEEL WHEELS

CANADIAN SUBSIDIARY — National Malleable and Steel Castings Company of Canada, Ltd. · 128 Simcoe St. · Toronto 1, Ontario

NACO STEEL WHEELS

WILLISON AUTOMATIC COUPLERS

Buys Railroad

Southern Ry. Co. has concluded an agreement to buy Interstate Railroad Co., a small soft coal hauling railroad in Virginia, from Virginia Coal & Iron Co.

The agreement, subject to approval by stockholders of both firms, would provide also for Southern's acquisition of all the equipment of Interstate, including its coal car fleet of 3,000 cars.

Interstate operates about 87 mi of track, including main line and branch line tracks, in the western part of Virginia and was built to serve the mines owned by the Virginia Coal & Iron Co. in that area. The latter mines are operated by Stonega Coke & Coal Co. under lease from Virginia Coal.

Harry A. DeButts, president of Southern, said that acquisition of Interstate will give Southern desirable access to another good source of bituminous coal by extending the road's lines into "one of the finest coal fields in the country."

To Build Dryer

United States Steel Corp.'s Columbia-Geneva Steel Div. will build a new coal-drying facility at Wellington, Utah, to be used in conjunction with a recently completed 13-story coal cleaning plant.

The dryer, similar to those used at major coal-cleaning installations in the east, will be the first of its kind west of the Mississippi, according to R. M. Von Storch, general superintendent of coal mines and quarries for the U. S. Steel division.

Called the Dorroco FluoSolids system, it takes clean wet coal from a screw conveyor and maintains the coal in a fluidized condition with upwardly moving hot gases. The drying is accomplished as the stream of coal floats on pressurized hot air over a refractory brick constriction plate of 14 ft dia.

The moisture-laden coal is heated to about 150 deg by the pressurized air at about 1,200 F, reducing the moisture in the feed to 5½% total moisture in the product. Capacity is about 800 tph.

Dried coal will be channeled into waiting railroad cars for shipment to the huge coke ovens at the Geneva Works.

Official Status

The National Coal Policy Conference has incorporated, changing it from its original voluntary status.

The group, representing coal producers, railroads, principal consumers, equipment manufacturers and the United Mine Workers, also chose officially its officers to serve through 1960.

Named were: George H. Love, chairman of the board of Consolidation Coal—chairman of the board; Joseph E. Moody, president, Southern Coal Producers Association—president; Gegory S. DeVine, vice president, Chesapeake & Ohio Ry.—treasurer; Alexander B. Hawes, Fowler, Leva, Hawes & Symington, a law firm—secretary.

Also named as vice chairmen on the board were: Raymond E. Salvati, president, Island Creek Coal Co.; John L. Lewis, president, UMWA; Howard E. Simpson, president, Baltimore & Ohio R. R.; Philip Sporn, president, American Electric Power Co., Inc.; and William Wearly, president, Joy Mfg. Co.

Rescue Contest

The 1959 National First-Aid and Mine Rescue Contest will be held at the Buffalo Memorial Auditorium, Buffalo, N. Y., October 5, 6 and 7.

The contest, held every two years under sponsorship of the Bureau of Mines and the Joseph A. Holmes Safety Association, is held in cooperation with the National Coal Association, United Mine Workers, state mining departments, local mining institutes and coal operators' associations.

Leading first-aid and mine rescue teams from various mining areas will compete for congressional medallions and for other awards in proving their skill at aiding the injured and in rescuing persons from simulated mine disasters.

Blasting Method Wins Approval

The Bureau of Mines announced its approval of the multiple short-delay method for blasting coal in underground mines, provided permissible explosives and permissible shot-firing units are used and certain special precautions taken.

Based on extensive research and testing in the Bureau's experimental coal mine at Bruceton, Pa., the special precautions are proposed in addition to those which normally should be followed in underground blasting and are listed in a new Bureau publication released recently. It discusses methods of readying the coal face, charging shotholes, preparing primers and making electrical connections.

Writen by John Nagy, acting chief of the Branch of Dust Explosives, the late Irving Hartmann, formerly chief, Branch of Dust Explosions and R. W. Van Dolah, chief, Div. of Explosives Technology, Booklet No. 7895 can be obtained by writing to the Bureau's Publications-Distribution Section, 4800 Forbes Ave., Pittsburgh 13.

(*Continued on p 56*)

Coal Men on the Job

SUPERVISORS of Armco Steel Corp. coal mines, Montcoal, W. Va., and members of local No. 6608, UMWA, meet to discuss safety performance at the Montcoal Nos. 1 and 7 mines. They are, front row (left to right): D. Mooney, superintendent; H. Webb, general foreman; C. Peters, vice president, local union; A. E. Oakley, superintendent; J. Hooten, shuttle car operator; L. G. Fitzgerald, U. S. Bureau of Mines instructor. Standing (left to right): B. Bradley, foreman; L. Nelson, trackman; B. Humphrey, helper; G. W. Clendenin, general foreman; H. Henderson, timberman; C. McNelley, shuttle car operator; J. Crutchfield, foreman; A. Martin, motorman; and R. L. Howell, shuttle car operator. The meeting was a review following completion of a U. S. Bureau of Mines accident course in which 342 persons from Armco Steel Corp. participated.

This No. 12 has to be dependable because "if the trucks can't move, the mine can't operate"

The Cat No. 12 Motor Grader, maintaining a strip mine haul road in Kingwood, W. Va., is a key machine.

"Keeping the haul road open for 14 to 27 trucks to move 1,000 tons of coal a day is vital. If the trucks can't move, the mine can't operate," explains C. G. Robertson, vice president of the Kingwood Mining Company. "The reason we use a Caterpillar machine is there is less down time and it's economical to operate."

This No. 12 operates the year around, 96 hours a week. It works over the 3½-mile haul road in just four hours. Other times it is used for clean-up work.

There are a number of reasons for its high production and dependability. Operators have good visibility. The mechanical controls they operate offer positive action, make blade adjustments precise. And now the all-transistor Preco Automatic Blade Control is available. It controls blade slope to an accuracy of ⅛ of an inch in 10 feet regardless of position of the grader or the unevenness of the terrain.

Another exclusive is the oil clutch which provides up to 2,000 hours without adjustment.

The 115 HP No. 12 is just one of a family of Caterpillar Motor Graders designed to do more work at lower cost with less down time than any other units in their class. There is also the 75 HP No. 112 and the big, new 150 HP turbocharged No. 14—the most versatile big grader ever developed.

If you have a job that can't afford excessive down time, see your Caterpillar Dealer. Ask to see the Cat Motor Grader that best fits your needs.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR

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LESS DOWN TIME, MORE PRODUCTION... CAT MOTOR GRADERS

People in Coal

Chairman Elect For 1960

WILLIAM C. McCULLOCH, chosen chairman elect of the American Institute of Mining & Metallurgical Engineer's Coal Div. for 1960, is well-backed with experience in the industry to handle the responsibilities of the position.

Employed as coal preparation manager for Roberts & Schaefer Co., Mr. McCulloch was born March 31, 1898, in North Dakota. He began his college study at the University of North Dakota going on later to take an M. S. in coal mining engineering at the University of Washington. While studying at Washington University, he held a U. S. Bureau of Mines fellowship at Northwest Experimental Station, Seattle, Wash.

He first went to work with the Pacific Coast Coal Co. as a coal-washing engineer, moving a short time afterwards to the U. S. Bureau of Mines in 1924 as a coal mining engineer.

In the following years he worked for Heyl & Patterson, Inc., was a chief chemist for Koppers Rheolaureur Co. and in 1935 entered the employ of United Electric Coal Co. as preparation manager.

He came to Roberts & Schaefer Co. in 1941, remaining with the firm ever since. He is a member of the Illinois Mining Institute and the Illinois Society of Coal Preparation Engineers and Chemists.

Inland Steel Co. recently announced that **Hobart B. Smith,** superintendent, preparation plant, has been moved up to superintendent, underground maintenance, replacing **E. C. Willis,** who is leaving Inland to join South-East Coal Co. **Robert Grimm,** preparation engineer, succeeds Mr. Smith and **Donald Jones,** assistant preparation engineer, moves up to preparation engineer, succeeding Mr. Grimm.

David H. Davis was honored by Ohio State University and the College of Engineering with a distinguished alumnus award. Dean H. A. Bolz called Mr. Davis a "pioneer in the mechanization and automation of the mining industry." Mr. Davis received a Bachelor of Mining Engineering degree in 1933 from the university and followed this up with his Master's degree in that field. Joining Pittsburgh Coal Co. he rose rapidly through numerous positions, becoming vice president of the newly formed Mathies Coal Co. in 1952. In 1958 he was elevated to assistant to the vice president of operations, Consolidation Coal Co., a position he presently holds. He is an active member and officer of many organizations including the AIME, the AMC and the NCA.

The Chesapeake & Ohio Ry. Co. has made **R. L. Barnett** and **T. J. Hayes** special representatives in the Coal Development Dept. with headquarters in Huntington, W. Va. Mr. Barnett entered the service of the C & O in 1942 when he was employed by the Operating Dept. and has been associated with the Coal Development Dept. since 1952. Mr. Hayes, with C & O since 1947, has been in the Coal Traffic Dept. in Wisconsin, West Virginia and Ohio.

Robert R. Williams Jr., manager of mines for the Western Div. of The Colorado Fuel & Iron Corp., recently received a distinguished achievement medal from the Colorado School of Mines. With Colorado Fuel since 1925, he is president of the Rocky Mountain Mining Institute and a member of numerous other mining and engineering societies.

Dennis A. Mooney has been appointed superintendent of the Montcoal operations of Armco Steel Corp.'s West Virginia coal mines. He succeeds **A. E. Oakley** who is retiring after 25 yr with Armco.

E. V. Bowman, formerly general superintendent for Winding Gulf Coals, Inc., has been promoted to vice president in charge of operations. Mr. Bowman, who lives in Beckley, W. Va., is a graduate of Virginia Polytechinc Institute with a B. S. in mining engineering. From 1948 to 1952 he served as engineer for Winding Gulf and was superintendent from 1952 to 1955.

G. A. Shoemaker, executive vice president, Consolidation Coal Co., was elected to his ninth consecutive term as president of the Western Pennsylvania Coal Operators Association, at its annual meeting in Pittsburgh.

Foreston Coal Co. has announced the election of **Edward C. Bizzarri** as vice president. Mr. Bizzarri came to Foreston

Femco systems and products for more efficient mining

Femco, Inc. engineers and develops systems for communication, monitoring and remote control which meet the rigorous requirements of the mining industry. Standard systems, together with certain other Femco products, are summarized below. We are prepared not only to supply the systems listed but also to develop special systems for other mining applications.

Communication Systems

Trolleyphone 3000—Newest model of the first practical mine communication system for use between moving and stationary locations. Microphone and loudspeaker conversation. Carrier system utilizes existing lines.

Loudspeaking Mine Telephone—Communication between fixed points underground. Two-way loudspeaker paging saves time—brings you into immediate contact. No ringing station after station. System is battery powered, 100% transistorized.

Wired Audio Systems—For cleaning and preparation plants, and for surface supervisory personnel. Paging over wide areas. Special four-wire communication cable. Handsets or integral microphones. Desk and paging stations available.

Cagephones—For cage installations in deep mines. Separate or integral microphone and speaker units. Low voltage battery powered. FM carrier current utilizes hoisting cable or other existing wires.

(East of the Mississippi, all Femco mine communication systems are distributed by National Mine Service Company.)

Monitoring and Remote Control Systems

Femco 709—Monitors fans and circuit breakers; automatically cuts off power into mine in the event of fan failure; provides selective control of all circuit breakers from a central point. Requires a single two-wire parallel circuit.

Pump Monitoring and Control—Provides centralized indication and control of pump operation. Requires a two-wire parallel circuit, which may be integrated with circuit for Femco 709 system.

Shot Firers

Femco 10-Shot—Capacitor operated, assuring adequate energy output. Bureau of Mines Approval #1603.

New 20-Shot—Manufactured by Femco for major powder companies. No "weak" shots—special safety circuit prevents firing unless capacitor is fully charged. If operation is stopped after charging starts, charge is drained from the capacitor—cannot enter wires. Bureau of Mines Approval #16D-9.

Mine Lights

Femco Fluorescent System—To illuminate working areas between the face and the loading head. Dust-proof, completely portable units give excellent illumination at low cost. Approved by Bureau of Mines for gassy atmospheres.

We will be pleased to send you full information on any of these systems and products, or to discuss any special problems of communication or remote control.

VMA 6771

Femco Inc.
Irwin, Pa.

Femco

COMMUNICATIONS: Carrier and wired audio systems for all mining and industrial applications. MONITORING: Fans, circuit breakers, valves, pumps, compressors, etc. TELEMETERING: Flows, pressures and other functions. REMOTE CONTROL: Pumps, valves, circuit breakers, sloping pit covers, furnace doors, cranes, or other moving equipment.

NEW NOLAN PORTA-FEEDER

SPLIT-TRACK MODEL

Special Features:

All Parts Easily Accessible
Cannot Foul with Axles, Coupler, or Brake Rigging on Mine Car
Less Down Time
Collects Less Coal
ASSURES MORE PRODUCTIVE OUTPUT!

Regular Features:

- Push-button operated
- Mounts on top of ties
- No excavation necessary
- No valves on track unit
- Cushioned anchorage
- Hydraulically protected from shock and overload
- Simplified hydraulic system
- Constant forward feeding motion
- Close-centered dogs
- Secured by rail clamps with shock-absorbing springs. No holes required in rails
- Shortest on the market—only 6 feet longer than mine car!

The only COMPLETE line of car-spotting and car-loading equipment available!

NOTE: Nolan makes a special model for drop-bottom cars. Nolan also makes a HOLD-A-TRIP for downgrades.

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George C. Hutchinson, Jr., 600 Keenan Bldg., Pittsburgh, Pa.
Huntington Supply & Equipment Co., 423 First Huntington Nat'l Bank Bldg., Huntington, W. Va.
E. C. Horne Machinery Co., 1736 Champa Street, Denver 2, Colorado
Frank C. Hemmett, P.O. Box 154, Castle Gate, Utah
J. L. Thomas, 429 S. 24th St., Birmingham 5, Ala.
John North Associates, P.O. Box 185, Hubert, Mich. (Chicago District)
Lovitt Safety Limited, Toronto 10, Canada

THE NOLAN COMPANY
106 Pennsylvania St., Beaverton, Ohio

People in Coal (*Continued*)

from Hughes & Co., of Cresson, Pa., and has served since 1947 as manager, northern bituminous department. It was also announced that **Maurice Cahn** has been promoted to vice presidency of Foreston Export Corp. Mr. Cahn, with the firm since 1956, had worked previously in the coal business in Japan.

William K. Dennison has been named mine superintendent in charge of Kaiser Steel Corp.'s coal mining operations at Raton, N. M. Mr. Dennison joined Kaiser when the firm purchased the Raton coal property from the St. Louis, Rocky Mountain & Pacific Co., in 1955. He is a Colorado School of Mines graduate.

Obituaries

Lawrence A. Henderson, 51, head supervisor of the Safety Dept., Coal Mine Operations, for Alabama Power Co., suffered a heart attack and died at his home April 24. He was associated with the mining departments of Tennessee Coal & Iron Div. of U. S. Steel for 11 yr and the Republic Steel Corp. for 5 yr. During 1946 he came as a mine supervisor with the Alabama Power Co., moving later into the Safety Dept. as a mine inspector. In 1955 he took charge of the department.

Eugene McAuliffe, retired chairman of the board of Union Pacific Coal Co., passed away on June 2 at the age of 92. Mr. McAuliffe started with the Northern Pacific R. R. and later became associated with the Frisco System in 1903 as a fuel agent. He then worked his way up through several positions and was president of Union Pacific by 1923. Retired in 1947, Mr. McAuliffe authored a number of books including "Railway Fuel," and "The Romance and Tragedy of Coal."

New Books

Nuclear Power Costs

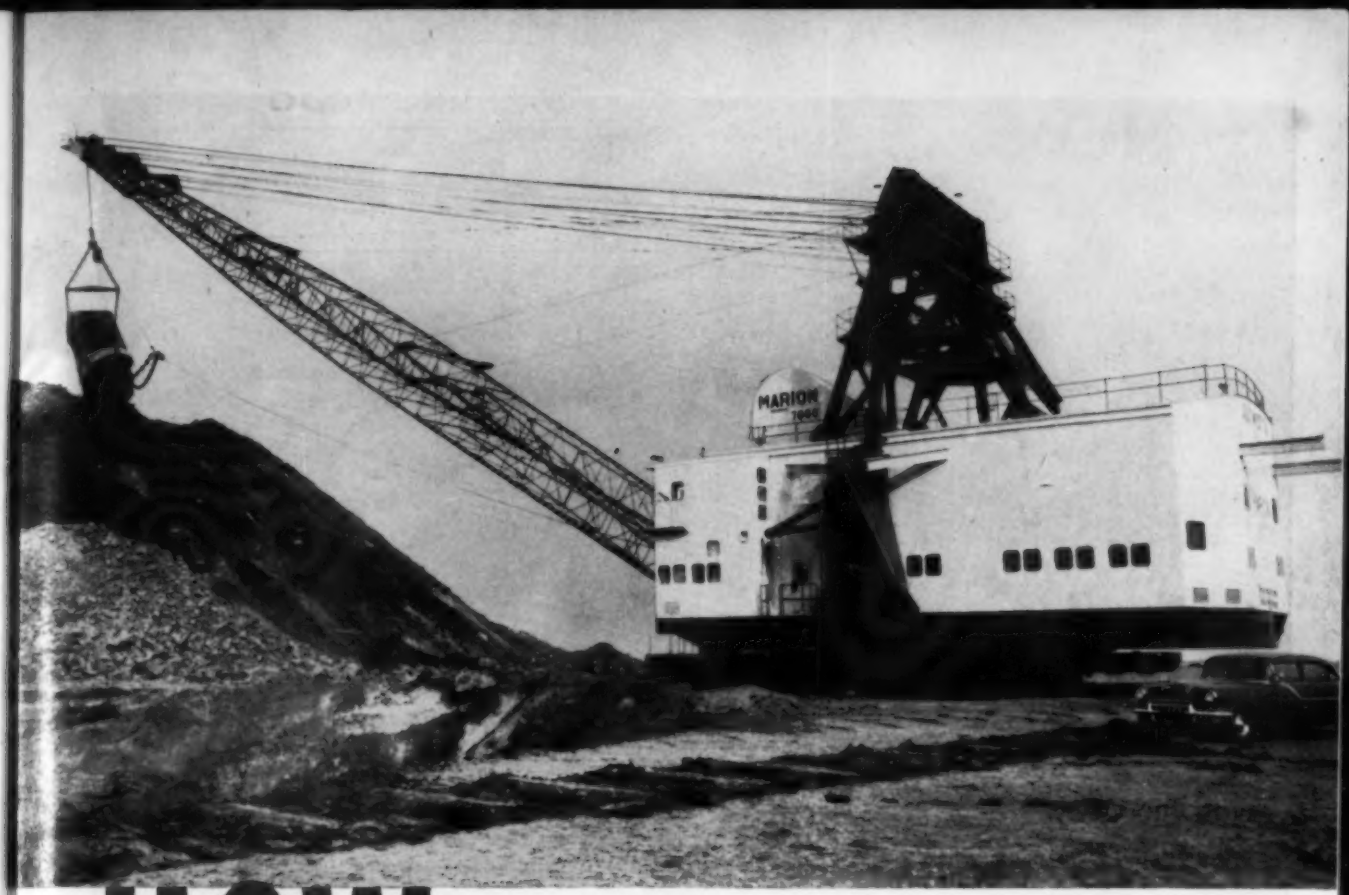
Introduction to Nuclear Power Costs, by Arnold Rochman. This monograph analyzes some of the factors which make up the total cost of nuclear power and shows how variations in their value may affect the over-all cost structure. The author emphasizes that there are severe limitations in all of the existing nuclear power cost estimates. And because of these limitations close prediction is not possible. However, if the course of development of nuclear power follows that of steam and hydro practice, then there is reason to suppose that estimates of operating characteristics of greater reliability should become available. 50 pp. 5½x8½-n; paper. Simmons-Boardman Publishing Corp., 30 Church St., New York 7, N. Y.

Methane Drainage

Drainage and Use of Methane From Coal Fields covers the progress made in the drainage and use of methane in European coal fields since 1956. Under the sponsorship of The Organization for European Economic Cooperation, experts reported on developments in the following countries: Belgium, France, United Kingdom and Germany. Studies show that all countries have made considerable progress and that there is an increase in the volume drained and the percentage used. Details of the drainage techniques as well as descriptions of the use of the methane provide valuable information for those faced with methane-drainage problems. 113 pp. 6x9½-in; paper. $1, Organization for European Economic Cooperation Publications Office, 1346 Connecticut Ave., N. W., Washington 6, D. C.

Engineering Handbook

Civil Engineering Handbook, edited by L. C. Urquhart is the fourth edition of this outstanding engineering reference book. Written by many of the country's leading authorities, the new edition gives hundreds of rules, working methods and engineering suggestions. The book has been extensively revised to bring engineers up to date on new developments. New and expanded material appears on photogrammetric surveying, interstate highway system requirements, soil classification, flow in pipes and channels, stresses in beams and frames, welded-steel construction, and reproportioning concrete mixtures for air entrainment. The complete coverage of civil engineering given in this handbook makes it an excellent reference for engineers in the mining industry. 1184 pp. 6½x9-in; cloth. $17.50, McGraw-Hill Book Co., Inc., 330 W 42nd St., New York 36, N. Y.



HOW TO HANDLE 90 FEET OF OVERBURDEN

The first problem in dealing with 90-foot overburden is to pick it up in meaningful bites. The next problem is to stack it high enough and far enough away to keep it from rolling back into the pit.

The 35 yard bucket and 220 foot boom of the Marion 7800 Walking Dragline provide sound, proved answers for both problems.

Here it is demonstrating its accomplishments in a Canadian mine where it is credited with cutting stripping time by one half to two thirds.

Whatever your stripping problem, there is a Marion machine of the type, size and capacity to assure fast handling at low unit costs.

CONSULT MARION MINING SPECIALIST

for lowest costs on your property!

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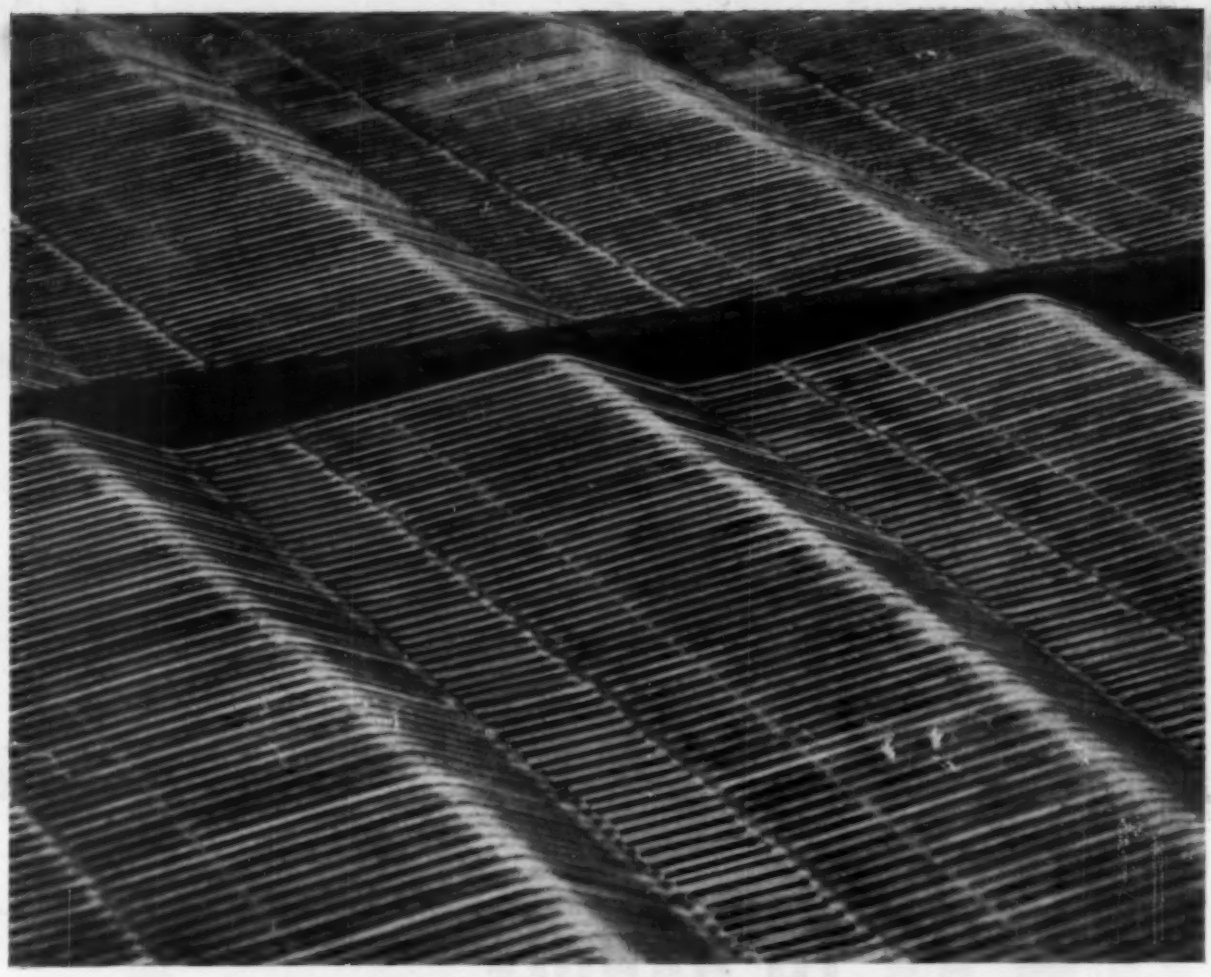

Close-up of Hendrick CASCADE shows "step" construction that improves dewatering efficiency.

screening capacity soars with new Hendrick CASCADE!

The new Hendrick CASCADE Screen eliminates flooding due to overloads in dewatering slurry and small coal. This means you can feed up to twice as much slurry and small coal onto the new Hendrick CASCADE Screen — and never worry about flooding. Its special cascade construction breaks up the flow layer and causes a tumbling action over the wedge shaped wires that greatly improves dewatering efficiency.

As a result, you can sharply increase draining capacity. Or, use smaller screens to achieve the same throughput as before, and save on space and invested capital.

Hendrick CASCADE Screens are now available with openings from ¼ to 1 m.m., in durable stainless steel. Write for more information, or call your local HENDRICK REPRESENTATIVE.

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41 DUNDAFF STREET, CARBONDALE, PA.

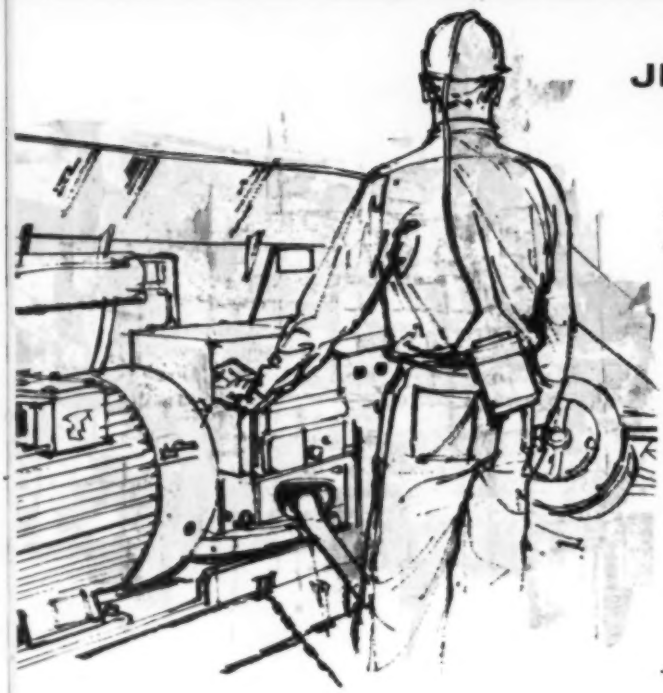
PERFORATED METAL SCREENS • WEDGE WIRE SCREENS • CASCADE WEDGE WIRE SCREENS • WEDGE SLOT SCREENS
RUBBER CLAD PERFORATED SCREENS • FLANGED LIP SCREENS • FLIGHTS • SHAKER AND CONVEYOR TROUGHS

now there are **4** types of Jeffrey crawler-loaders

The payoff: *for new highs in efficiency, you can apply the crawler-loader whose height, power and loading rate is best suited to the seam.*

ONLY 25" HIGH... 81C LOADER CLEANS OUT SEAMS WHERE LOW CLEARANCE MAKES OTHER LOADERS USELESS. AVERAGE RATED CAPACITY 10 TONS PER MINUTE

JEFFREY



JEFFREY CRAWLER-LOADERS

GENERAL SPECIFICATIONS

	81-C	81-AL	81-AH	97-A
Rated Capacity T.P.M.	10	10	10	18
Tram Height	25"	32"	36"	43" or 48"
Overall Length	25'-8½"	24'-1"	24'-1"	25'-11"
Overall Width	7'-5¼"	7'-5¼"	7'-5¼"	7'-8"
Tram Speed D.C.	137	137	137	160
Tram Speed A.C.	85	85	85	160
Gathering Arm Speed—R.P.M.	55	55	55	53
Conveyor Chain Speed—F.P.M.	372	372	372	360
No. & H.P. Gathering Arm Motors (D.C.)	2—15	2—15	2—15	2—25
No. & H.P. Gathering Arm Motors (A.C.)	2—20	2—20	2—20	2—33
No. & H.P. Conveyor Motors (D.C.)	Uses Gathering Arm Motors			2—10
No. & H.P. Conveyor Motors (A.C.)	Uses Gathering Arm Motors			2—20
No. & H.P. Tram Motors (D.C.)	2—15	2—15	2—15	2—25
No. & H.P. Tram Motors (A.C.)	2—20	2—20	2—20	2—33/8.25
H.P. Pump Motor—A.C. or D.C.	4	4	4	8
Weight in lbs. approx.	21000	21000	21000	38000

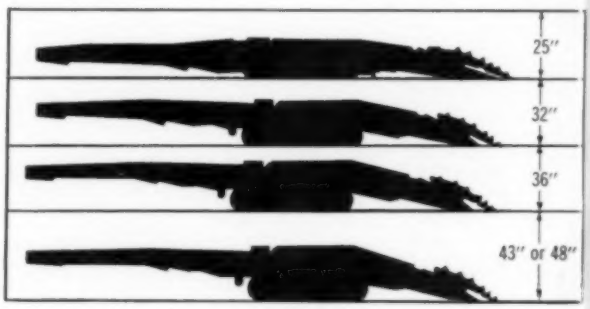
Voltages: Loaders can be built for operation on any of the following voltages: 250 or 500 V, DC; 440 V, AC, 3-ph., 60-cy, 415 V, AC, 3-ph., 50-cy.

these advantages mean lower cost per ton

1

height

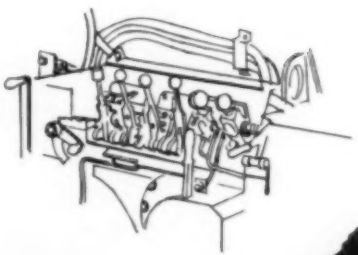
Four loaders with five heights, means you can put the correct height loader in the seam height for which it's designed. This assures proper clearance for lumps and convenient height of controls for the operator.



2

power

Available for direct current or alternating current power. Liberal size motors.



3

capacity

Jeffrey Loaders are setting high tonnage records with low maintenance cost and very little down time.

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Call or write your nearest Jeffrey District Office.

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TEXACO ORGANIZED LUBRICATION CAN HELP YOU...

Keep his guns from killing your profits

His grease guns are aimed at your profits; they can help boost them – or eliminate them altogether. Here's why:

You used to need a different grease for nearly every job. That meant 20 or 30 lubricants at the mine, with the almost inevitable danger of misapplication – and damaged machinery. *Now, with the rapidly increasing mechanization of mine operations, this can be a ruinously expensive policy.*

Yet, unless you are operating on the basis of a modern lubrication survey, *the chances are that this situation still exists at your mine!*

A Texaco Organized Lubrication Plan uses a minimum number of proper oils and greases – including newly developed multi-purpose lubricants – to reduce your inventory by as much as 80% and virtually eliminate this problem.

Get the details on Texaco Organized Lubrication. Contact your local Texaco Lubrication Engineer soon. He can give you an approximate dollar-and-cents prediction of the money you can save by adopting the Texaco Plan. Texaco Inc., 135 East 42nd Street, New York 17, N. Y.

LUBRICATION IS A MAJOR FACTOR IN COST CONTROL

(PARTS, INVENTORY, PRODUCTION, DOWNTIME, MAINTENANCE)

Current Coal Patents

By: Oliver S. North

Self-cleaning belt roller, A. W. Calder (assigned to Joy Mfg. Co., Pittsburgh, Pa.), May 12, 1959. Improved self-cleaning belt roller having spaced blades extending outwardly from the shaft of the roller for engaging loose dirt to prevent accumulation thereof adjacent to the belt. No. 2,886,169.

Centrifuge for separating fine granular material, W. G. J. Heckmann (assigned to Klockner-Humboldt-Deutz A.G., Koln-Deutz, Germany), May 12, 1959. This apparatus makes use of a very lightweight oscillating drum; thereby, it is possible to achieve oscillatory motion having a high axial separation during the reverse movements thereof without increasing the size of the drum shaft bearing or decreasing the life of the bearing. No. 2,886,179.

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SHAFT PRODUCTION EQUIPMENT

including: Sheaves • Skips & Loaders • Self-Dumping Cages, Platform Cages, Cagers

SHAFT HAULAGE EQUIPMENT

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Raising Production SINCE 1901 Connellsville MANUFACTURING

CONNELLSVILLE, PENNSYLVANIA

Bore mining apparatus having means to measure the angle between units thereof, J. W. Heimaster and R. L. McNeill (assigned to Union Carbide Corp., a corporation of N.Y.), May 12, 1959. Improved device for plotting the exact location of a remotely controlled bore mining machine during its operation. No. 2,886,299.

Treatment of carbon-containing materials, N. L. Dickinson (assigned to The M. W. Kellogg Co., Jersey City, N. J.), May 12, 1959. Method for producing a hydrogen-rich gas from coal, coke, or other solid carbon-containing materials. The finely divided raw material is entrained in a stream of oxygen and steam at relatively high temperatures and pressures. No. 2,886,421.

Explosive compositions and method of preparing them, Andrew Hyslop Jr. May 12, 1959. Method of making a low-cost explosive for use in mining operations, especially coal mining, using liquid oxygen and a liquid hydrocarbon. The hydrocarbon is sprayed into a zone of congelation, and the resulting filaments are saturated with liquid oxygen. No. 2,886,424.

Indicating mechanism for underbunker coal control gates, M. N. McCloskey (assigned to Webster Mfg. Inc., Tiffin, O.), May 26, 1959. A position indicating device for the control gates associated with underbunker coal conveyor systems of large capacity and comprising a series of individual bins. No. 2,888,170.

Roof supports, A. W. Duncan (assigned to The Mining Engineering Co. Ltd., Worcester, England), May 26, 1959. Design for a mine roof support of the hydraulic type having improved resistance characteristics. No. 2,888,230.

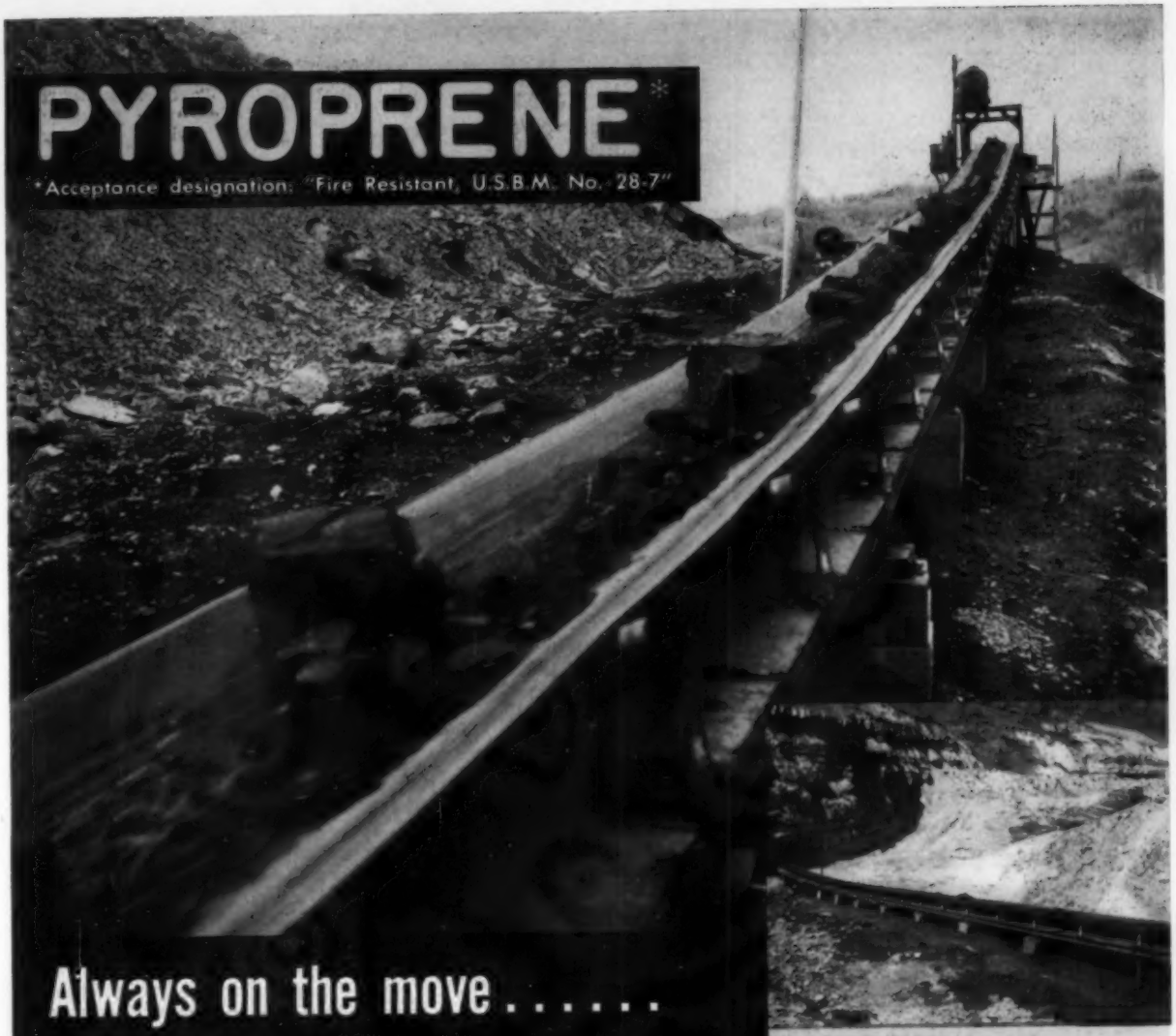
Roof supports, A. W. Duncan (assigned to The Mining Engineering Co. Ltd., Worcester, England), May 26, 1959. Design for a hydraulic accumulator which will store energy derived from subsidence pressure on mine supports, and later release this energy under controlled conditions to do useful work in the mine. No. 2,888,231.

Apparatus for separating solid materials of different specific gravities by means of a suspension, M. R. Dru (assigned to Societe Jaruza A.G., Chur, Zurich, Switzerland), June 2, 1959. In an apparatus for washing coal and separating slate, sand, etc., therefrom, the dense liquid flows through a sedimentation vat so that the float material passes over an overflow sill or weir. Provision is made for continuously evacuating the waste. No. 2,889,043.

Apparatus for washing coal and ore,

PYROPRENE*

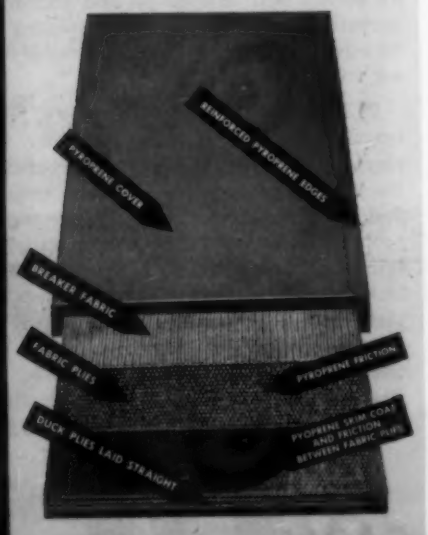
*Acceptance designation: "Fire Resistant, U.S.B.M. No. 28-7"



Always on the move . . . . . 1,500,000 tons per year

Huge sharp-edged pieces ride over ½ mile on the Acme-Hamilton Pyroprene Belt which is running on a Barber-Greene conveyor. Over a million and a half tons of coal a year travel on this belt. Trouble is nonexistent. Proof-positive that Acme-Hamilton belts haul top capacity loads for longer periods with no loss of time, or maintenance.

Fire Resistant Pyroprene Compound, used in Acme-Hamilton U.S.B.M. accepted belts, will not feed or spread fire. The cover is Pyroprene; fabric plies and breaker fabric are sealed with Pyroprene before the belt is built. Cover has exceptional resistance to cutting, abrasion and gouging. Write Acme-Hamilton, Dept. CA-92.



Acme Hamilton

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Divisions: Acme Rubber Mfg. Co. • Hamilton Rubber Mfg. Corp.

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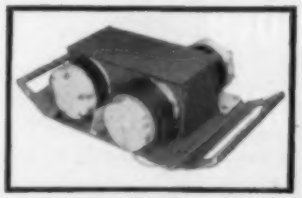
now... put 7500 Volt portable power cable to work... easily, quickly, safely!

Extend high-voltage a-c power quickly and easily as work progresses—with safe, convenient PLM Cable Couplers. Built especially for service both in open-pit and deep-mining operations, they meet the increasing need for equipment that will permit use of higher a-c voltage systems.

PLM Cable Couplers simplify joining lengths of portable cable together or to electric shovels or portable substations. Each coupler consists of connecting plug and socket, fully insulated and ruggedly protected and weatherproofed against electrical or mechanical damage. Optional locking and grounding features meet complete range of requirements. Rating, 300 amperes, 7500 volts, grounded neutral. Write today for descriptive bulletin 375. PLM Products, Inc., 3881 West 150th Street, Cleveland 11, Ohio.



3 AND 4-WAY ASSEMBLIES
Plugs or sockets are also supplied in 2, 3 or 4-way assemblies for connecting 2, 3 or 4 cables.

SAFE
no exposed connections

SAFE
electrical and key-type interlocks guard circuit

SAFE
contacts always made or broken within housing

CABLE FITTINGS · TERMINATORS · SPLICING KITS

CABLE PLM COUPLERS

Patents (*Continued*)

J. Turpin (assigned to Societe Preparation Industrielle des Combustibles, Fontainebleau, France), June 2, 1959. Improved method and apparatus for jig washing coal or the like wherein all or part of the heavy products from the washing beds is automatically recycled as needed to the front of or at a suitable point in one or more of the beds. A pressure responsive detecting device is used. A sufficient quantity of heavy products is maintained in each bed to prevent discharge therefrom of light products which would become misclassified due to lack of heavy products in the bed. No. 2,889,045.

Boring-type miner, R. F. Risse (assigned to Goodman Mfg. Co., Chicago, Ill.), June 9, 1959. In a continuous miner having multiple pairs of boring arms, each of a pair of material receiving throats has a conveying reach of a flight conveyor thereat. These reaches, which are parts of a single endless conveyor, lie substantially in a common plane and converge toward each other to form a common discharge portion where the flights are preferably in interdigitating relationship. No. 2,889,910.

Swivel connection for conveyors, R. F. Boersma and R. F. Lo Presti (assigned to Goodman Mfg. Co., Chicago, Ill.), June 9, 1959. Improved swivel connection between a bridge conveyor connecting a continuous miner and a gathering conveyor. This connection has as much as 180° swiveling movement and does not bind or stick, so that the support structure for the swivel connection may freely move translatively along the room or gathering conveyor. No. 2,889,913.

Rope frame conveyor and articulated idler assembly therefor, E. R. Bergmann (assigned to Goodman Mfg. Co., Chicago, Ill), June 9, 1959. Improved rope frame conveyor and flexible troughing idler assembly therefor having three dimensional flexibility for maximum impact absorption, load carrying ability, and ease of operation and maintenance. No. 2,889,918.

Process and apparatus for treating suspensions, F. J. Fontein (assigned to Stamicarbon N.V., Heerlen, Netherlands), June 9, 1959. An improved process is described for treating coal washing magnetite solutions in a closed circuit wherein the dilute suspension is thickened in a static or gravity thickener and is continuously recycled, together with undiluted suspension, into the circuit for re-use. No. 2,889,925.

Westmoreland Coal Company sets the pace in COAL PREPARATION . . .

The entire Coal Preparation and Thermal Drying Plant at Hampton No. 4 was designed and built by H & P on a turnkey basis. 440 TPH of 5″x0 coal is processed by equipment which includes:

- **H & P Wet Cyclones**
- **H & P Sieve Bends**
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- **Reineveld Centrifugal Coal Dryers**

This very latest coal preparation and drying equipment, developed by H & P, was combined with proven methods and techniques. The result is a plant designed for a profitable future, producing uniformly prepared and dried coal at low cost. Completely closed coal and refuse circuits have eliminated all plant bleed.

Assure yourself a perfect product and profitable operations like Hampton No. 4 and contract for an H & P-designed Coal Preparation Plant with its advanced processing equipment.

Write for brochure 557—Serving the Coal Industry.

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...a good name in industry

QUALITY GEAR DRIVES and FLEXIBLE SHAFT COUPLINGS

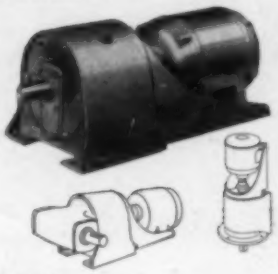
THE FALK CORPORATION, MILWAUKEE 1, WIS. *Representatives and Distributors in many principal cities.*

● The helical and spiral bevel gears in Falk gear drives assure maximum mechanical efficiency attainable—98½% per gear mesh under full load.

ALL-MOTOR MOTOREDUCERS *up to 75 hp.*

All-steel units for use with any NEMA foot-mounted motors within rated capacities of the gear drives. Standard output speeds from 1.2 to 780 rpm (with 1750 rpm motors); as low as .032 rpm in semi-standard designs. Also Integral units, from 1 to 40 hp.

Ask for Bulletin 3100.



SHAFT MOUNTED DRIVES *up to 50 hp.*

All-steel units, horizontal or vertical. Output speeds between 420 and 5 rpm. Maximum torque rating at low speed shaft: 41,000 lb-in. Consult Factory for higher capacities and for flange mount and screw conveyor drives.

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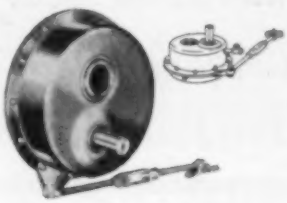

SMALL SPEED REDUCERS *up to 138 hp.*

Concentric Shaft Ratios from 1.49:1 to 970:1. Max. torque at low speed shaft: 80,000 lb-in. **Right Angle** Ratios from 5:1 to 1460:1. Max. torque at low speed shaft: 73,000 lb-in.

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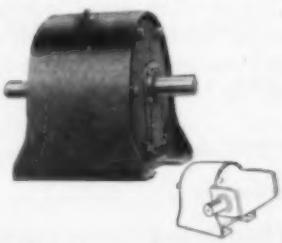
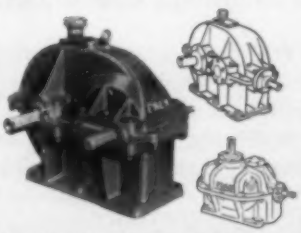


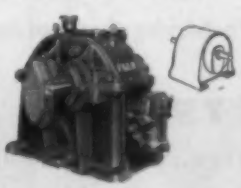
LARGE SPEED REDUCERS *up to 3500 hp.*

Parallel Shaft up to 3500 hp. Ratio range: from 2:1 to 300:1. Max. catalog torque at low speed shaft: 1,950,000 lb-in. Bulletin 1110B. **Right Angle Horizontal** up to 1000 hp. Ratio range from 1.5 to 515:1. Max. catalog torque at low speed shaft: 569,000 lb-in. Bulletin 2105B. **Right Angle Vertical** up to 760 hp. Ratio range from 6:1 to 430:1. Max. catalog torque at low speed shaft: 714,000 lb-in. Shafts up or down. Bulletin 2110B.



HIGH SPEED DRIVES ... *reducers or increasers.*

Parallel Shaft Cataloged units up to 5,000 hp or 10,000 rpm. Ratios up to 40:1. Bulletin 1105. **Concentric Shaft** Cataloged units up to 225 hp or 4500 rpm. Ratios up to 25:1. Bulletin 1106.



STEELFLEX COUPLINGS *protect connected machines.*

Hp range: ½ through 72,000 hp at 100 rpm. Exclusive grid-groove design cushions shock loads, accommodates reasonable degrees of shaft misalignment. Basic Type F for 9 out of 10 industrial applications, horizontal or vertical.

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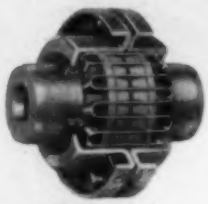


Basic Type F

AIRFLEX COUPLINGS

Designed for mounting shaft-to-shaft, shaft-to-flywheel, or shaft-to-flange.

15 sizes covering a range from 5 through 2880 hp at 100 rpm. Ideal for applications which have irregular torque characteristics in driving or driven machines (internal combustion engines, reciprocating compressors, etc.).

Ask for Bulletin 8100.

SINGLE HELICAL and HERRINGBONE GEARS

Exclusive Falk extra-depth, high pressure angle gear teeth provide greater strength and protection against abrasion. AGMA ratings.

Diameters up to 18 ft.

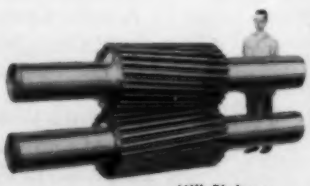
Face widths up to 6 ft.

Diametral Pitch: ¾ to 6 dp.

Hub or ring gears in solid or split designs.

Hub Gears

Ask for Engineering Reports 6170 and 6171



Mill Pinions

Special GEAR DRIVES for any application.

Special HIGH SPEED DRIVES ... over 50,000 rpm.

Marine PROPULSION DRIVES for turbine and diesel.

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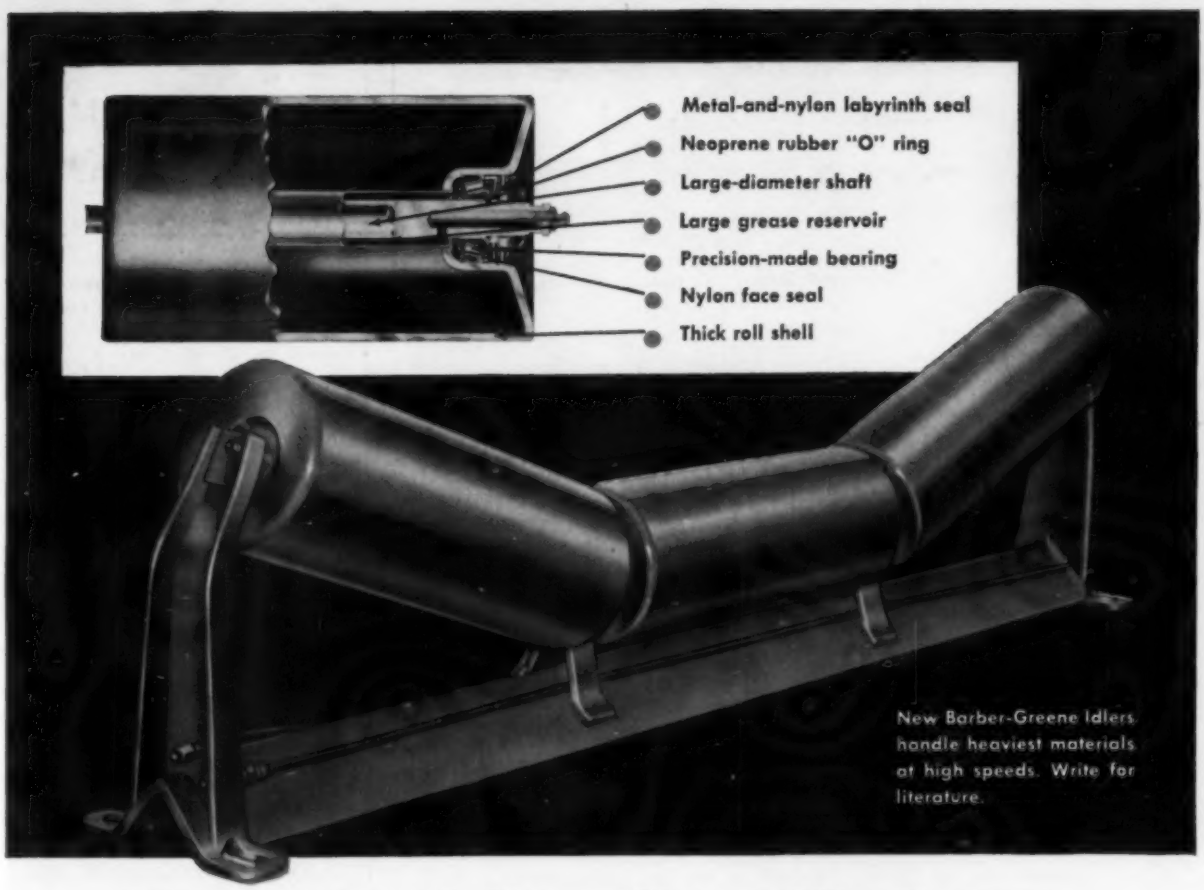

Metal-and-nylon labyrinth seal
Neoprene rubber "O" ring
Large-diameter shaft
Large grease reservoir
Precision-made bearing
Nylon face seal
Thick roll shell
New Barber-Greene Idlers handle heaviest materials at high speeds. Write for literature.

Increase idler life with these new heavy-duty Barber-Greenes

Barber-Greene's famous line of belt conveyor idlers has now been expanded to include two entirely new series of heavy-duty units. Both series offer many revolutionary design improvements that assure longer life on every job. Both are built to handle large lumps and heavy materials at high speeds. These new series include a complete range of types for every application.

Important advantages are:

Revolutionary grease seals—The combination labyrinth and face seals are the most advanced in the industry. Made of metal and nylon, they seal grease in . . . dust and dirt out, allowing long lubrication intervals and lengthening bearing life. Neoprene rubber "O" rings effectively prevent moisture from entering bearing.

Rugged end brackets—Die-formed carbon-steel end brackets, twice as strong as castings of the same thickness, are ribbed for greater rigidity.

Precision-made bearings—Tapered roller bearings are precision-made to give many thousand hours of service.

Large-diameter shafts—Shafts, made of special-accuracy cold-drawn steel, up to 1¼" in diameter. They are firmly anchored in stands by sturdy clamps and locking plates.

Virtually unbreakable stands—Jig-welded, all-steel stands maintain roll alignment despite the impact of large lumps. Heavy, inverted base angle is self-shedding. Heavy, formed steel feet up to ½" thick.

Thick roll shells—Rolls made of heavy steel tubing up to ¼" thick. Strong welds completely around roll ends assure rugged, long-life units. Roll edges ground smooth to prevent belt wear.

Large grease reservoirs—Rigidly fitted seamless steel tubing forms large grease reservoir, providing ample reserve which permits longer lubrication intervals.

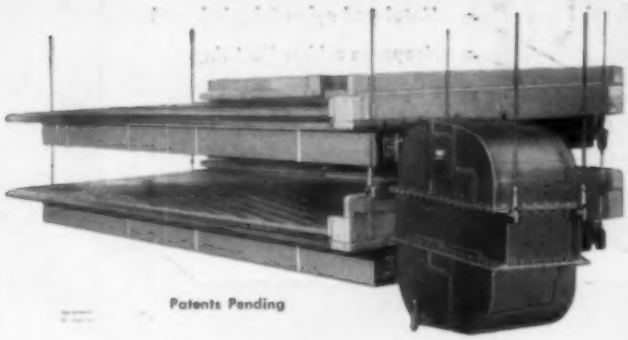
59-9-1PE

Write for new bulletin.

Barber-Greene BG

AURORA, ILLINOIS, U.S.A.

CONVEYORS . . . LOADERS . . . DITCHERS . . . ASPHALT PAVING EQUIPMENT



Patents Pending

Twice as Much Washed Coal in the Same Plant Area

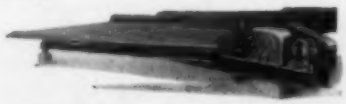
That's exactly what happens when you install a CONCENCO® 77 Table with suspended twin decks. This high producing table occupies no more plant space than was formerly required for the floor-mounted single deck table. Both decks, however, have exactly the same capacity, efficiency and characteristics as the former single deck of the still famous SuperDuty® table with this one exception . . . they operate from a synchronized head motion in a floating suspension that substantially reduces impact to the building. This, in turn, makes it possible to use lighter construction for any preparation extensions or new plants.

If you have not already studied all the advantages of the new CONCENTO 77 Table, it will pay you to do so.* Send today for Bulletin 77 and full information.

* Special models are available for high refuse feeds.

For Single Deck Installations, Use the SuperDuty® No. 7 Table

Where its use may be indicated, the SuperDuty DIAGONAL-DECK® Table continues to offer highly efficient and economical preparation of fine sizes.* For full information, simply ask for Bulletin 119.



THE DEISTER ★
CONCENTRATOR
COMPANY
923 Glasgow Ave. • Fort Wayne, Ind., U.S.A.
CONCENCO PRODUCTS

★ *The ORIGINAL Deister Company • Inc. 1906*

Equipment Approvals

Eleven approvals were issued during May.

The Jeffrey Mfg. Co.—Type MT-66 shuttle car; three motors, two 23 hp and one 22 hp, 440 V, AC. Approval No. 2F-1468A, May 6.

The Jeffrey Mfg. Co.—Type MM-76CM Colmol; three motors, two 100 hp and one 50 hp, 440 V, AC. Approval No. 2F-1469A, May 7.

Mine Safety Appliances Co.—Part No. 83067, 20-shot blasting unit. Approval No. 16D-10, May 6.

Joy Mfg. Co.—Type XB30RA-1E extensible belt conveyor; three motors, each 15 hp, 250 V, DC. Approval No. 2F-1470, May 11.

The Long Co.—Type 188-E loading machine with type PT-118 or PT-218 Piggyback conveyor; three motors, one 80 hp and two 5 hp, 220-/440 V, AC. Approval Nos. 2F-1471 and 2F-1471A, May 11.

Koehler Mfg. Co.—Model 287-1A electric cap lamp. Approval No. 6D-32, May 13.

Koehler Mfg. Co.—Model 189-1A single-shot blasting unit used in conjunction with Model 282 cap lamp. Approval No. 12D-30, May 20.

National Mine Service Co.—Type 30 TorKar; one motor, 15 hp, 500 V, DC. Approval No. 2F-1323A, May 22.

Goodman Mfg. Co.—Type 584-30 shuttle car; three motors, each 20 hp, 550 V, AC. Approval No. 2F-1472A, May 27.

Goodman Mfg. Co.—Type 584-31 shuttle car; three motors, each 20 hp, 550 V, AC. Approval No. 2F-1473A, May 27.

The Long Co.—Type TDF-10 mobile face drill; one motor, 5 hp, 230 V, DC. Approval No. 2F-1474, May 29.

In addition to the above, identification symbol No. 114-BM was assigned to the Phelps-Dodge Copper Products Corp. to identify cables that have been accepted by the Bureau as being flame resistant.

August Special . . .

The Kolbe wheel . . . development and use at Cuba mine, United Electric Coal.

TAKES OFF ITS HAT TO NOBODY!

5/8 BETHLEHEM STEEL 3 1/2

HEX BOLTS
HEAVY HEX NUTS

Machine, lag, and carriage bolts.
All sizes. Quick delivery from stock.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
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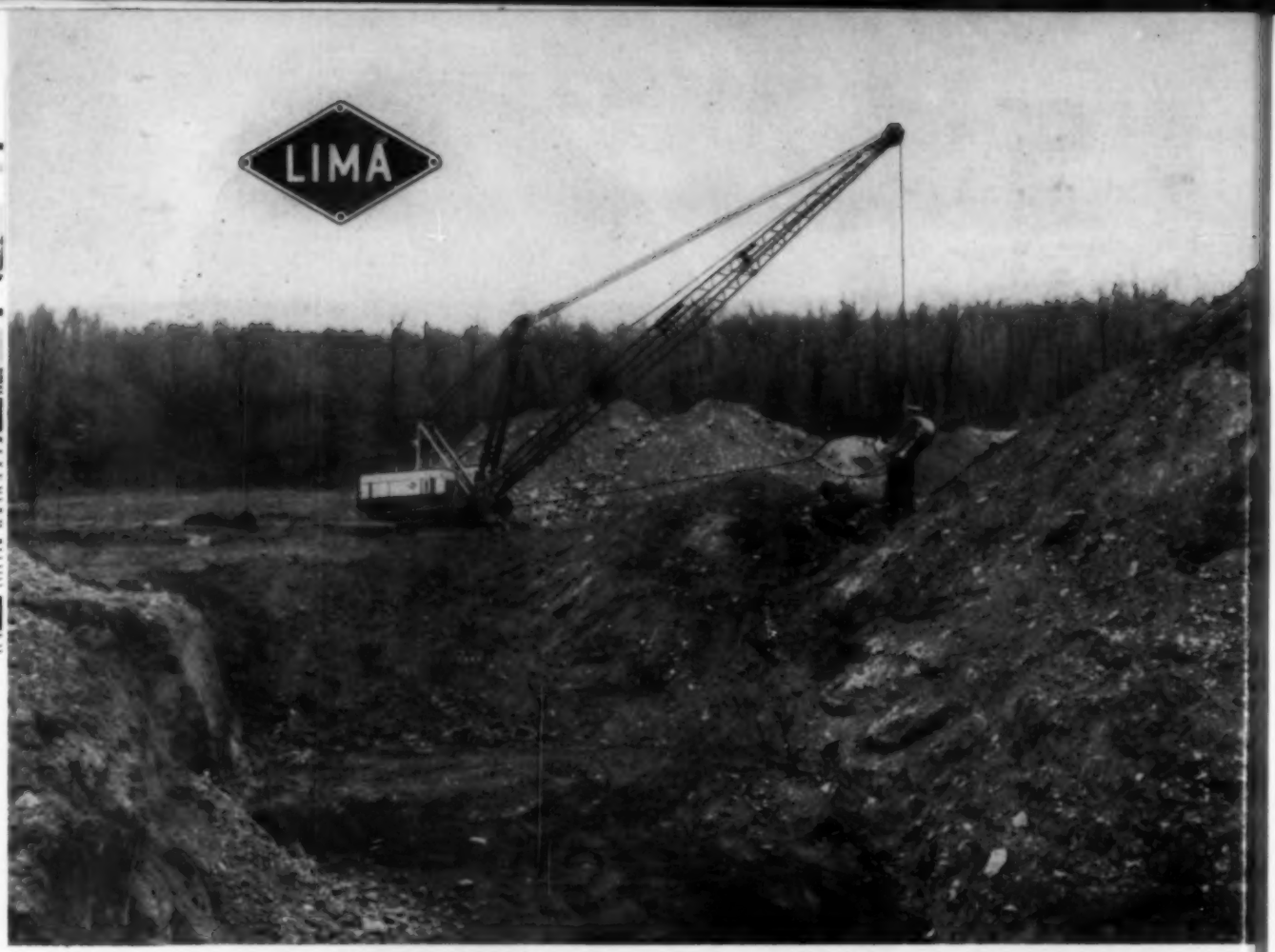

Lima Type 2400, equipped with 120-ft. boom and 7-cu. yd. dragline bucket, speeds removal of overburden in coal stripping operations near Parker, Pa.

Giant Lima 2400 delivers brute force for profitable high-output stripping

"It really pays to buy a Lima!" That's what Edward G. Kriebel, C & K Coal Co. partner, says about the firm's Lima 2400 Dragline. "We handle more yardage per shift with the Lima than we could with any competitive machine I know of," he tells us.

Lima Maintenance Low

"Lima gives you more machine per dollar than competitive makes. Its extra quality is clear to anyone who knows heavy equipment. Component parts are heavier and better made. Maintenance is low, distributor and factory service excellent.

"It's fast, smooth and easy to operate. Extra long, wide crawler tracks give the 2400 a rock-solid base on any surface, yet permit it to propel itself anywhere on the stripping site. It's a money-making machine!"

Interchangeable front end attachments make the Lima 2400 one of the most versatile heavy-duty rigs you can buy today! It can be converted in the field from variable capacity dragline to 6-cu. yd. shovel or 110-ton crane.

Quality Built Throughout

Anti-friction bearings throughout simplify lubrication, reduce wear. Big, wide air operated clutches respond instantly, lessen operator fatigue. Torque converter reduces shock loading, prevents engine stall, gives cables longer life, helps lower maintenance cost. Gears are spline fitted to shafts . . . all shafting is heat-treated alloy steel. All wearing parts are induction hardened for long life.

These are only some of the many quality features that pay off for you when you buy a Lima. There's a Lima type and size for every mining need. Draglines variable; shovels to 6 cu. yds.; cranes to 110 tons. Get full information. See your Lima distributor now or write us.

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LIMA Construction Equipment Division, Lima, Ohio

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Shovels • Cranes • Draglines • Pullshovels • Roadpackers • Crushing, Screening and Washing Equipment

Photo: Courtesy of Boone County Coal Corp.

Now . . . one *new* lubricant and one hydraulic oil meet all your daily underground needs

By teaming only two Sunoco petroleum products, miners are increasing tonnage, because they are running longer . . . without shutdowns for inspection and maintenance. They're simplifying their inventories and lessening the chance of mix-ups. Parts are lasting longer.

The new lubricant that makes this possible—Sun's 740A-EP—is an all-purpose, semifluid, extreme-pressure mine-machine lubricant. It sticks like a grease . . . pours like an oil . . . resists water and heat . . . protects against corrosion and rust.

Combine new Sun 740A-EP with one of Sun's quality hydraulic oils and you have reduced your daily underground lubricant inventory to an absolute minimum. This is just one more example of how you can save money with Sun quality . . . the best economy of all. For information, call locally, or write to Dept. CA-7. SUN OIL COMPANY, *Phila. 3, Pa. In Canada: Sun Oil Company Limited, Toronto & Montreal.*

MAKERS OF FAMOUS CUSTOM-BLENDED BLUE SUNOCO GASOLINES

AMERCLAD
PORTABLE POWER CABLE
types W and G

Amerclad power cable is extremely flexible, and will withstand continual reeling on and off drums. Because of its light weight and great toughness, it is widely used for electric shovels, dredges, cranes, excavating machinery and similar equipment.

Type W is recommended for potentials up to 2000 Volts. It has no shielding or ground wires. Type G is good for 5000 volts. When rated over 2000 volts, the insulated conductors are shielded with PS nonmetallic shielding, and all type G cables contain ground wires.

AMERCLAD
LOCOMOTIVE GATHERING CABLE

This single-conductor cable is especially designed for gathering-reel type electric mine locomotives. Standard conductors are copper, but they can be furnished with steel wire reinforcing for greater tensile strength. Copper conductors, on the other hand, withstand kinking better and they are easier to splice.

The cable is reinforced with tough seine twine and the flame-resistant Amerprene jacket is lead-sheath vulcanized.

AMERCLAD
PORTABLE CORDS
types SO and SJO

These cords are identical except that type SO has a heavier jacket. This cord is extremely flexible and is designed for use with portable tools and appliances. The tough Amerprene jacket is highly resistant to oil, grease and water. Many different types of cord construction are available.

AMERCLAD
TWIN PARALLEL
MINING MACHINE CABLE
types W and G

Compared to two-conductor round cables, Twin Parallel Cables occupy less space on a reel or drum, and are lighter in weight. They are recommended for use up to 600 volts.

Amerclad Twin Parallel Mining Machine Cables feature the AS&W "Bridgewall" construction. This is literally a bridge of neoprene between the two insulated conductors and the ground wire. The "Bridgewall" construction enables this cable to withstand crushing weight and severe abrasion without service interruption. This cable also features dynamically balanced, fully engineered rope-lay conductors to insure equal tension.

AMERCLAD
2-CONDUCTOR ROUND
MINING CABLE

The color-coded conductors are insulated with a heat-resisting rubber compound, then twisted and covered with a reinforced oil-resistant Amerprene jacket. Interstices between conductors are filled with neoprene.

The jacket is flame-resistant and can withstand tremendous abuse in all kinds of weather.

AMERCLAD
WELDING CABLE

The tremendous number of extremely fine copper wires in this cable provide an unusual degree of flexibility. The cable lies flat without kinking or snarling and there is no undue strain on the operator's wrists. A separator is applied between copper and rubber, so it is easy to strip the insulation to make a splice.

3 great Tigerweld Bonds

WEDGE-TYPE

The Tigerweld Wedge-Type Bond is primarily designed for quick installation on tracks that may have to be moved, but this durable bond holds so well that many mines use it for permanent installation. It can be installed in a few minutes with a high speed drill and a 3-pound hammer. In spite of its ease of installation, the wedge-type bond holds with a grip that won't shake loose. But if you want to remove the bond from temporary trackage, you can hammer it out as easily as you put it in.

BF-10

The Tigerweld BF-10 has self-clamping terminals to make installation easy. The terminals can be secured to the rails by a few taps of a hammer. And they stay firmly in place while the steel-to-steel weld is made. The BF-10 has great resistance to fatigue stresses. It can be reclaimed and used again and again.

BF-12

The Tigerweld BF-12 Bond is designed for quick, permanent low-resistance installation by welding. Just drive it on the base of the rail and it stays in position ready to weld. No special clamp is necessary. Your maintenance crews can install more bonds per day at lower cost. And once the BF-12 Bonds are installed they're on to *stay!*

All of these bonds are butt-welded. That means that in every case all the wires are electrically connected—permanently—to the solid end piece. Butt-welding will consistently develop almost full strength of the strand on a tensile test to destruction. So always specify Tigerweld Bonds. They're *all* butt-welded!

American Steel & Wire Division of USS **United States Steel**

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KANSAS CITY . . . . . Power & Light Building
MILWAUKEE . . . . . Bankers Building
NEW YORK . . . . . 71 Broadway
PHILADELPHIA . . Suburban Station Building
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ST. LOUIS . . . . . 1221 Locust Street
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COLUMBIA-GENEVA STEEL DIVISION, San Francisco, Calif., Pacific Coast Distributors
TENNESSEE COAL & IRON DIVISION, Fairfield, Ala., Southern Distributors
UNITED STATES STEEL EXPORT CO., 30 Church St., New York, N. Y., Export Distributors

Coal Abroad

In Korea . . . Anthracite Comes of Age

Switch from wood and imported bituminous to hard coal for fuel requirements is figured to save the nation $20 million.

There is a quiet little revolution in South Korea. Factories, railroads, locomotives and home heating units, which have always burned wood or imported bituminous coal, are being converted to use anthracite briquettes.

Throughout South Korea's history its citizens have plucked and hacked trees from the forests and mountainsides to feed the appetites of wood-burning heating systems, leaving the earth barren and the rice paddies and corn fields unprotected from flood and drought. Or, if wood wasn't used, bituminous coal was imported at up to $39 a ton, wringing from the tiny not too wealthy country an unnecessary $20 million.

This sapping of lumber reserves, which could have been used for other purposes, and of dollars, much of which represented United States aid, has been termed unnecessary by critics because South Korea has almost unlimited reserves of anthracite coal.

Now, with the swing to hard coal briquettes, which tests proved could be burned without loss of power in engines with a small super-charger, 100 railroads have been converted to burn anthracite instead of bituminous and engineers are at work to convert the nation's other 400 conventional steam engines in a similar way. There are 22 briquette factories under contract to the railroads, producing about 300,000 tons of the newly-developed fuel.

The government-controlled Daihan Coal Corp., produces about 80% of South Koreas coal, some 4 million tons a year. Helped by The United Nations Korean Reconstruction Agency a greater degree of mechanization and efficiency is being achieved. In conjunction with the anthracite revolution the government has started a reforestation program involving the planting of millions of tiny trees and seedlings and calling for police protection of all undergrowth.

Overseas Flashes

AFRICA—It looks as if plans for a multi-million dollar "oil-from-coal" industry planned for the Federation of Rhodesia and Nyasaland may be shelved. It has been suggested by an engineer studying the plan that the conversion process be allowed to develop before any steps are taken. He told the board of the Wankie Colliery, which had been studying the plan, that owing to daily changes in development of equipment for making oil from coal, any machinery ordered now would be out-of-date tomorrow.

JAPAN—Two Japanese geologists arrived in Anchorage, Alaska, to make a study of coal deposits in the Matanuska Valley. Representing the Japan Petroleum Exploration Co., Ltd., of Tokyo, the geologists came in the wake of another project in the Bering River area

BEST FOR LOW SEAMS
THE WILCOX CONTINUOUS MINER

Now in the fifth year of producing coal from Alabama to Nova Scotia and as far west as Oklahoma . . .

HAS BEEN PROVEN

- *By producing coal in seams ranging from 28 to 46 inches thick*
- *By producing coal under roof conditions where other mechanical equipment has failed*
- *By producing coal with lower maintenance cost per ton than any miner on the market*
- *By producing up to 60 tons per man per shift*
- *By its unparalleled safety record*
- *By repeated orders of 95% of our customers from 1 to 12 miners per customer*

THESE FACTS along with the low initial cost, the low 25½ inch overall height, and many other features of the Wilcox Continuous Miner have been responsible for opening many new seams throughout the country.

THE WILCOX CONTINUOUS MINER IS YOUR ANSWER FOR MORE TONS PER MAN AT LESS COST PER TON

For additional information call CLifford 2-6555 Beckley, West Virginia, or write

WILCOX MANUFACTURING COMPANY
P. O. BOX 217 **RALEIGH, WEST VIRGINIA**

which was determined as economically unsound by mining engineers. While the quality of Bering River coal was found to be good, it was impossible to determine how much there was because of badly broken ground caused by earth upheavals.

RUSSIA—A Soviet combine that carries out all operations in a coal drift has completed trials in the Donbas region, the Russians announced. A complex of several mechanisms, the combine reportedly cuts, loads, transports, timbers and roofs, A crew of three operates the combine by remote control. A report said the machine mines almost twice as much coal as present "ordinary ones."

POLAND—An agreement was signed recently between Poland and Hungary regarding the exploitation of slag heaps at Silesian coal mines.

Preparation Facilities

Elk River Coal & Lumber Co., Rich Run mine, Widen, W. Va.—Contract closed with Industrial Engineering & Construction Co., Inc., for a coal preparation plant to handle 700 tph of 7x0 washing the 5x⅜. Centrifugal drying is provided for the ⅜x0 and for the 1x⅜. Five sizes will be made with facilities for crushing the plus 1 sizes and rescreening.

A. C. Benninger Coal Co., Tionesta, Pa.—Contract closed with The Jeffrey Mfg. Co. for No. 100 unit washery to handle 75 tph of 5x0 coal.

Bituminous Output

YEAR TO DATE	PRODUCTION
June 13, 1959	190,420,000
June 14, 1958	179,042,000

1959 output 6.4% ahead of 1958.

A month earlier output was 5.1% ahead of 1958.

WEEK ENDING	PRODUCTION
June 13, 1959	9,035,000
June 14, 1958	8,255,000

Anthracite Output

YEAR TO DATE	PRODUCTION
June 13, 1959	8,938,000
June 14, 1958	9,396,000

1959 output 4.9% behind 1958.

A month earlier output was 6.1% behind 1958.

WEEK ENDING	PRODUCTION
June 13, 1959	408,000
June 14, 1958	467,000

Collyer PORTABLE CORDS AND CABLES FOR MINES...

Flat Twin Mining Machine Cable
(Types W & G)

Locomotive Gathering Cable

for use on:

Drills
Cutters
Loaders
Conveyors
Locomotives
Shuttle Cars

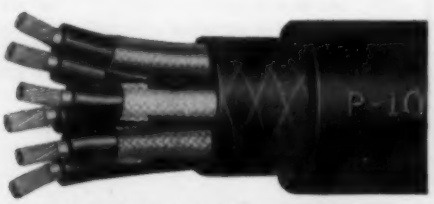
. . . and all types of continuous mining equipment above and below ground.

Portable Power Cable 2-4 Conductor Type G
2-6 Conductor Type W

Shovel Cables
(Classes A, B, C and D)

Concentric Mining Machine Cable

Portable Cords (Types S, SO, SJ, SJO)



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LIVE BETTER ELECTRICALLY

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INSULATED WIRE CO.
257 Pawtucket Ave.,
Pawtucket, R. I.

We can supply one single cutting bit... or a complete Ripper Head for continuous mining

When you want something special, Bowdil has the staff and facilities for economical designing and custom-building.

Our "throw-away" Bits are tempered & hardened to best suit your cutting.

There are 5 TYPES, 3 TEMPERS MEDIUM, TOUGH & HARD

We make Cutter Bars for all machines, Chain for any bar, and Sprockets of every type, many available from stock

Also:

"No-Bend-'em" Spike Pullers

"Changeable-Points" Hand Picks

"No-Tools-Needed" Rope Sockets

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BOWDIL

ALWAYS *RIGHT* ON THE JOB

a million shots without a miss!!!*

Upper Left: INSTANTANEOUS (Copper Leg Wires)
Upper Right: INSTANTANEOUS (Iron Leg Wires)

Over the years, Cyanamid Electric Blasting Caps have achieved this enviable record for never-miss shooting. Millions of mine . . . quarry . . . and construction shots have been fired accurately, dependably and economically by using Cyanamid — the *best* in electric blasting caps! Cyanamid makes a cap for every blasting need.

Instantaneous, regular or split-second delays . . .

Cyanamid Electric Blasting Caps offer you these advantages: CHOICE OF DELAYS • TIMING ACCURACY • HIGH DETONATION STRENGTH • SUPERIOR INSULATION • COLOR-CODED FOR EASY IDENTIFICATION.

Make every shot count! Insist on Cyanamid Blasting Caps and Explosives!

**An actual, documented case history of a leading coal mining company.*

AMERICAN CYANAMID COMPANY
EXPLOSIVES AND MINING CHEMICALS DEPARTMENT
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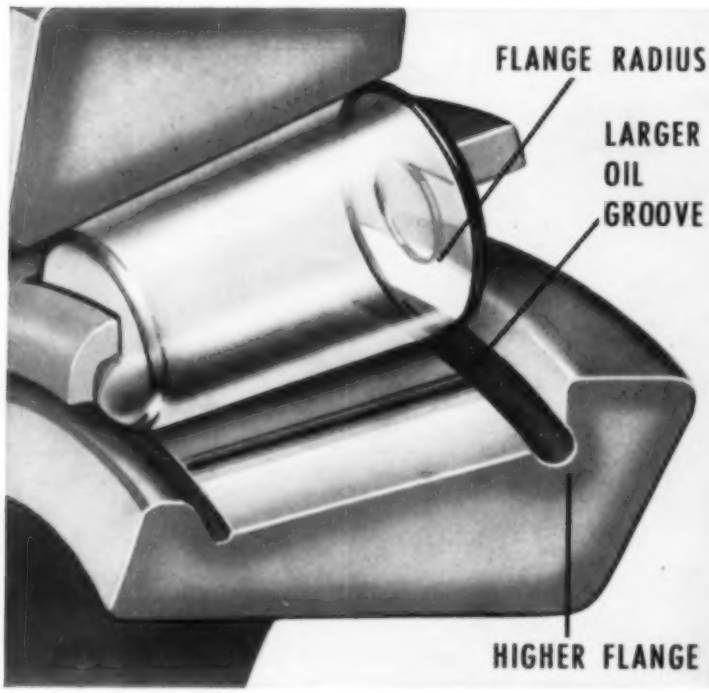
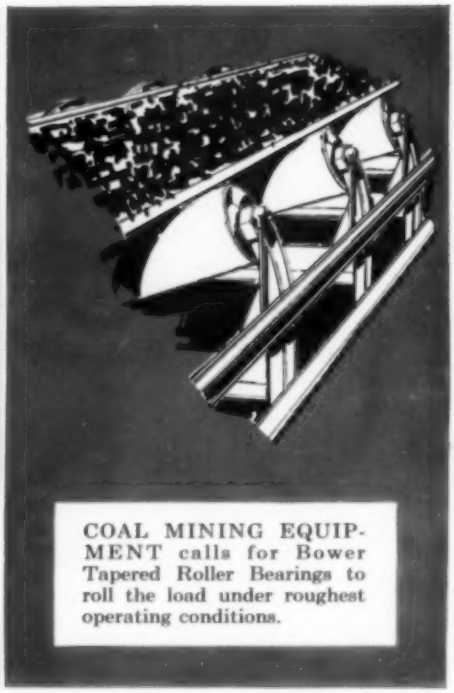
CYANAMID

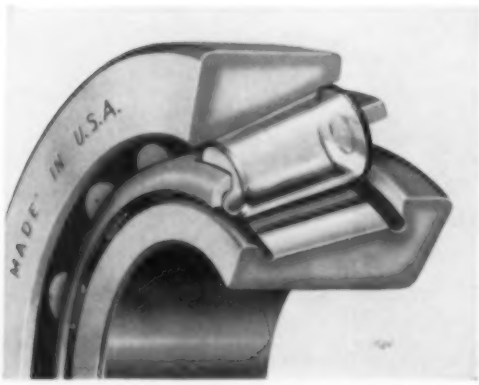
Better products, *faster,* from your Bearing Specialist:





COAL MINING EQUIPMENT calls for Bower Tapered Roller Bearings to roll the load under roughest operating conditions.

Bower designs 3 "long-life" refinements into one small section of tapered roller bearings



Bower Tapered Roller Bearings are *Spher-O-Honed:* 1. Roller heads are spherically contour-ground, need no "run-in"; 2. Oil groove is bigger for positive roller-head lubrication; 3. Honing superfinishes inner and outer races for longer life.

Extra-high flange, larger oil groove and shoulder radius help reduce friction so bearings give high-tonnage service longer!

Bower's skill at the design board pays a bonus in service life when tapered roller bearings go to work in your machines. Take for example these *three* design refinements in *one* small area:

Higher flange gives rollers a large, "two-zone" contact area, cuts unit pressure on each roller; it also improves roller alignment, thereby reducing wear and resulting "end-play". **Larger oil groove** insures positive roller-head lubrication; increases efficiency and decreases wear. **Shoulder radius** helps the oil groove maintain an unbroken film of lubricant on the roller heads. All three add up to longer bearing life, lower cost to you.

Whether you need tapered or straight roller bearings, check *first* with the Bearing Specialist who handles the Bower line. He stocks both types; gives fast delivery on each. Call today!

BOWER ROLLER BEARINGS

FEDERAL-MOGUL SERVICE

DIVISION OF FEDERAL-MOGUL-BOWER BEARINGS, INC. • DETROIT 13, MICHIGAN

BEARING BOWER ROLLER BEARINGS SERVICE

coming and going

you take your profits on ~~the~~ every run with the Lee-Norse BUS & JITNEY

Lee-Norse
MINE PORTAL BUS

■ There's no wasted motion with this self-propelled Portal Bus because it is fast on the take-off, saving manpower time for conversion into more tonnage. And it is designed for safety, with hydraulic operated running brakes plus mechanical emergency and parking brakes direct on the wheels. For severe grades, optional electric dynamic system produces braking effect from the motor for *extra* safety under all conditions. Also the split roof construction gives operator unimpeded, all directional view, while the trolley pole is always within quick reach. This bus is powered by 15 H.P. motor and will haul 13 to 17 men.

Lee-Norse
MINE JITNEY

■ The Mine Jitney is the "Jack-of-all-Trades" of the mine fleet because its versatility enables it to be used on the regular job and for emergency. It can handle the job of furnishing fast, safe transportation of key personnel, maintenance crews and special groups; and can double up as an ambulance or fire-fighting equipment car. Designed with twin braking systems for added safety. Powered with either 5 or 7½ H.P. motor. Holds up to 7 men comfortably. Optional equipment: Plexiglas windshield, fire extinguisher, stretcher equipment.

LN Lee-Norse Company
CHARLEROI, PENNSYLVANIA

SPECIALISTS IN COAL MINING EQUIPMENT

Buys Coal Lands

The Northern Pacific Ry. Co. has agreed to give The Montana Power Co. a 30-yr lease on 3,300 acres of coal lands near Colstrip, Mont., belonging to the railroad. The transaction requires federal approval of assignment to the utility of government leases now held by the railroad.

Purchase of the coal deposits, said J. E. Corette, president and general manager of Montana Power, should have the effect of making electric power available in Montana throughout the indefinite future at low cost as compared to power costs in other parts of the nation.

The land, 100 mi east of Billings, Mont., is reported to have reserves of from 50 to 60 million tons of sub-bituminous coal near ground level which Montana Power plans to recover by large-scale strip mining. Northern Pacific president, R. S. MacFarlane, said the railroad will receive mining royalties from the operation as well as substantial revenue for hauling coal from the field.

Montana Power has voiced the belief its future power supply will come primarily from steam-electric generating plants. The firm now operates one 66,000-kw steam power plant at Billings using oil and gas as fuel. The purchase of the Colstrip property is one step in a plan for construction of a second steam-electric plant and other future plants, according to the report.

DAVID H. DAVIS (center), assistant to the vice president, Consolidation Coal Co., receives congratulations from Dean H. A. Bolz of the Ohio State University College of Engineering. Because of his achievements (see p 30) Mr. Davis was granted the Distinguished Alumnus award. Looking on are: N. G. Fawcett (left), president, Ohio State; and Professor J. Richard Lucas, Mining Engineering Div.

For The Kids

This summer will mark the 25th year Eastern Gas & Fuel Associates has run a summer recreation camp for the sons and daughters of its mine and store workers.

By the end of the summer, about 900

Save time and money with...

the Galis MODEL 100 Master-Duster

Maintain your rock dust percentage constantly on roof ribs and floor with this tested Model 100.

It's the newest machine for mine upkeep in the Galis line of efficient performers.

Check these specifications

GALIS Model 100	ROCK DUSTER
Width Over Tires	72 in.
Length	15 ft.
Height	32 in.
Dust Capacity	2500 lbs.
Dust Discharge Rate Variable to	350 lbs. per min.
Tram Speeds Variable	18 to 130 F.P.M.
Gross Weight	9000 lbs.

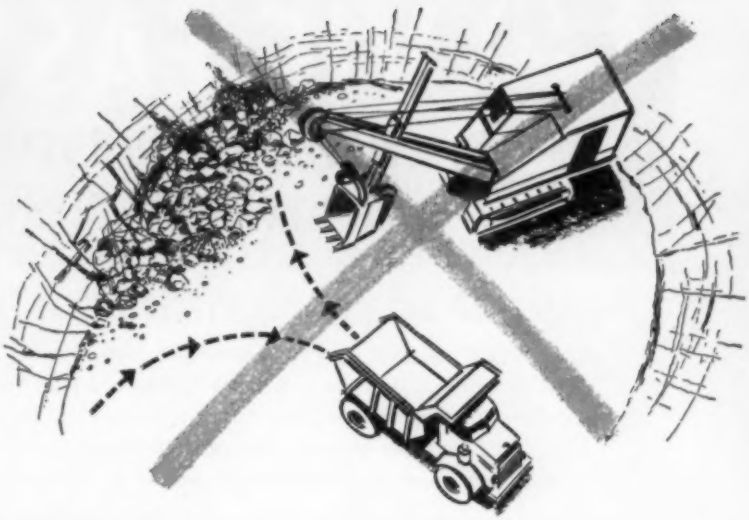
Tires—7.50-10 10 ply
4 Wheel Hydraulic Drive
3 Point Suspension
Readily adapted for host dusting and/or rail use.

Galis ELECTRIC & MACHINE CO. MORGANTOWN, W. VA.

Also Repairs to all Underground Mining Equipment
Phone Morgantown 4668

SHORT TURNS
...speed hauling in restricted areas

Even though most haulers make good time on straightaway haul and return, many of them make a poor showing on the entire work cycle. That's because of maneuvering difficulties in restricted load and dump areas. Conventional trucks, for instance — with full-length, 1-piece frame, hydraulic bowl hoist, and automotive-type steer — often slow down production and increase haul costs because of time-wasting maneuvering delays.



Maneuverability is no problem to the pivot-steer LeTourneau-Westinghouse Rear-Dump. Bowl on this off-road L-W hauler is connected to 2-wheel Tournapull® prime-mover by a geared kingpin. Big, instant-acting electric motor swings prime-mover 90° right or left for quick, easy spotting under shovel or at dump. Short-turning L-W hauler makes U-turns in less than its own length, in *only about 70% of length* with bowl raised. Result? Tournapull Rear-Dump saves time in the cut and dump... delivers more tonnage per day.

U-Turn Widths

Model	Tonnage	Length	Bowl Down	Bowl Raised
B	35	36'7"	35'0"	27'0"
C	22	29'6"	28'8"	20'8"
D	11	24'10"	24'8"	18'8"

R-1898-G-1

Ask for full specifications on L-W Rear-Dumps

LETOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

CUT COSTS WITH THE NEW

VIC-EASY®

METHOD OF JOINTING LIGHTWEIGHT PIPE

SAVE UP TO 60% IN PIPING COSTS!

Now there's no need to buy overweight pipe. Thanks to Victaulic engineering, you can select lightweight pipe "job-rated" to your conditions and install it the *new VIC-EASY* way. You'll cut costs of pipe, transportation, and handling —you'll save from 30% to 60% in man-hour installation.

1. LIGHTWEIGHT PIPE in thicknesses from .065" handles high pressures. Leading mills make sizes 1¼" to 12", steel or aluminum, with *VIC-EASY roll-grooved ends.*

2. VIC-EASY PORTABLE GROOVER rolls grooves into pipe in seconds. Manually or power-operated, this groover removes no metal...retains full wall thickness.

3. VICTAULIC SNAP-JOINT COUPLING assembles and locks by hand—no wrenches or tools required. Other bolted styles of Victaulic Couplings alternately usable.

4. VICTAULIC FULL-FLOW FITTINGS team up with our couplings and lightweight pipe to provide a *complete VIC-EASY system*...cuts costs of installation *and* operation.

For complete information write for Bulletin AA7

VICTAULIC COMPANY OF AMERICA
P. O. BOX 509 • Elizabeth, N. J.

News Roundup *(Continued)*

boys and girls between the ages of 8½ and 14 yr will have enjoyed 2-week vacations at Camp Thomas E. Lightfoot near Hinton, W. Va., or Camp Washington-Carver near Beckley, W. Va.

Eastern Gas reports that this will bring to more than 17,000 the total of youngsters who have had the benefit of mind- and body-building recreation since the firm's first summer camp was held in Fayette County, W .Va., in 1935.

Mines, Companies

Chesapeake & Ohio Ry.'s new coal loading dock at Toledo, Ohio, recently set a Great Lakes record by dumping 6,653 tons of coal into a ship in 1 hr 30 min.

The rated capacity of the $7 million mechanical shiploader, said to be the largest and fastest in the world, is 6,000 tph from railroad cars into vessels.

Anticipating future blast furnace coke requirements, Sharon Steel Corp. has acquired extensive coal properties near Kittanning, Pa., from the Pittsburgh & Shawmut R. R.

To be completed and placed in operation within 12 mo, a modern coal-cleaning plant and coke oven will be installed near the mine. The coal seam has been drilled and tested, indicating that coke produced at this plant will have an excellent analysis and structure, said Sharon.

Limited operations are to get underway at the Rochester & Pittsburgh Coal Co.'s new O'Donnell No. 2 mine, on a 7-mi extension of the B & O R. R. near Sand Fork, Gilmer County, W. Va.

The mine will produce about 3,000 tons per day of low ash, low-sulphur Pittsburgh seam coal. Preparation facilities include complete wet cleaning of all sizes and heat drying of the slack coal.

The fire that hit the preparation and cleaning plant of the Tioga Coal Corp. recently did damage estimated at about $750,000.

J. N. McQuade, vice president, said it would be some time before the mine could resume full operations. The mine, owned by Maust Co. of New York, is near Tioga, 18 mi west of Richwood, W. Va.

Utilization

Low-grade coal and lignite deposits hold the key for boosting power potential in the Missouri River drainage area,

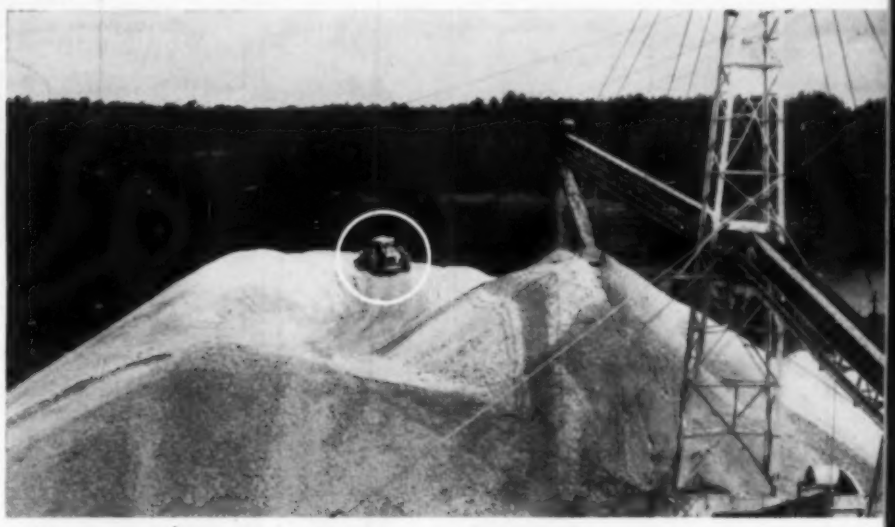
Switch in tractors means big savings

for Hedrick Gravel and Sand Co.

B. V. Hedrick Gravel and Sand Co., Salisbury, N.C. produces up to a million tons of gravel and sand yearly at its 2000-acre Rockingham quarry. Until a couple of years ago, the firm used two 120-hp crawler-tractors for clean-up and miscellaneous jobs. But, as is usual wherever footing is abrasive, track maintenance costs were sky-high. In addition, the crawlers took far too long to travel long distances between job assignments.

This situation, management realized, called for a mobile rubber-tired tractor. And time studies showing actual tractor *work time* indicated that probably only one of these new, mobile tractors would be needed:

The firm found what it was looking for in powerful, speedy, 218-hp LeTourneau-Westinghouse Tournatractor®. Of the switch in tractors, Gen. Mgr. E. A. Goodman, Jr. today says, "This single rubber-tired tractor certainly meets our need . . . it drives job-to-job very effectively." Adds operator Luin Tucker, "It's fast and makes my job twice as easy. It'll do more work than the two crawlers did, and maintenance is low."



Maintains stockpiles — With 12'-wide dozer blade, Hedrick's Tournatractor efficiently spreads conveyor-dumped gravel. With big, multi-disc air brakes — totaling 3,762 sq in. of brake surface — operator has sure, safe control, giving him confidence to work near pile's edge.

Illustrated and described here are a few reasons why Hedrick's rubber-tired L-W tractor gets more work done faster . . . safer . . . at less cost.

Why don't *you* check on savings possible with a LeTourneau-Westinghouse high-speed Tournatractor at your pit? Ask for details and demonstration. No obligation.

CT-2008-MQJ-1

Handles clean up — L-W Tournatractor cleans up around hoppers, draglines, rail sidings. Unit also spots RR cars. Gear shift is instantaneous . . . operator can always apply effective pulling, pushing power without loss of vital momentum.

Clears brush, strips overburden — Powerful Tournatractor clears brush, topples trees, and strips overburden from new mining area. Tractor's 4 big, high-flotation tires provide excellent traction. Blade is controlled by instant-acting electric motor.

Travels anywhere — 17-mph L-W tractor drives anywhere under its own power. When traveling between assignments, Tournatractor handles haul-road maintenance, improves drainage—keeps haulers moving at safer, more profitable speeds.

LETOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

ILLUMINATION

M-S-A® Permissible Electric Trip Lamp
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New Edison Model S Electric Cap Lamp
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M-S-A® H-H Inhalator
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M-S-A® Model 2100
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M-S-A® Mine Fire
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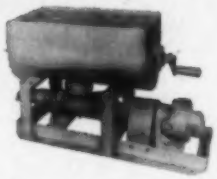
M-S-A® Mine Fire Hose Bulletin No. 1203-2

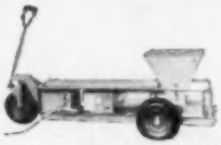
Miners work safest, operators get greater tonnage with

Complete MSA®

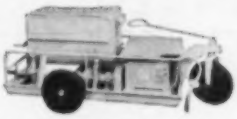
ROCK DUSTING AND DUST COLLECTING



M-S-A® Model 80 Slurry Rock Dust Distributor—Bulletin No. 1201-6



M-S-A® Bantam 400 Rock Dust Distributor Bulletin No. 1201-2



M-S-A® Slurry Rock Dust Distributor Bulletin No. 1201-4

M-S-A® Thru-Steel Dust Collector Bulletin No. 1207-1

RESPIRATORY PROTECTION

M-S-A® Self-Rescuer® Bulletin No. EC-1

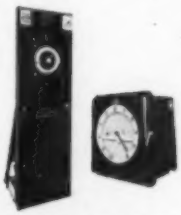
M-S-A® Dustfoe #66 Respirator Bulletin No. 1004-3

M-S-A® Chemox® Breathing Apparatus Bulletin No. B-14

M-S-A® McCaa® Two-Hour Breathing Apparatus Bulletin No. BB-3

METHANE DETECTION

M-S-A® Methane Alarm Bulletin No. 0809-2



M-S-A® Methane Recorder Bulletin No. 0706-1

M-S-A® Wolf Junior Flame Safety Lamp Bulletin No. 0807-1

M-S-A® Methane Detector Type W-8 Bulletin No. 0809-4

M-S-A® Methane Tester Type M-6 Bulletin No. 0809-3

FIRST AID EQUIPMENT

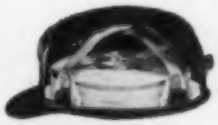
M-S-A® Miner's First Aid Cabinet Bulletin No. 0401-2

M-S-A® Jenkins Stretcher Bulletin No. 0408-10

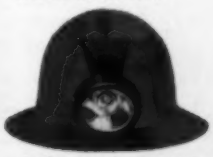
M-S-A® Emergency First Aid Outfit Bulletin No. 0408-10

M-S-A® Unit First Aid Kits Bulletin No. 0401-2

HEAD PROTECTION WITH "FIXED-CROWN" SUSPENSION



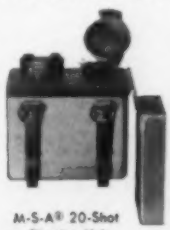
M-S-A® Comfo Cap® Bulletin No. 0601-3



M-S-A® Type K Skullgard Hat Bulletin No. 0601-4

PORTABLE INSTRUMENTS

M-S-A® Portable Oxygen Indicator Bulletin No. 0817-1



M-S-A® 20-Shot Blasting Unit Bulletin No. 0901-4

M-S-A® Carbon Monoxide Indicator Bulletin No. DS-3

Product Lines

With these MSA products on the job, men and machines mine more coal safer, thriftier and more efficiently than was ever before possible.

MSA serves mining areas everywhere, with conveniently located warehouses and complete lines of safety equipment. When you have a safety problem, MSA is at your service. Our job is to help you.

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MINE SAFETY APPLIANCES CO. OF CANADA, LIMITED
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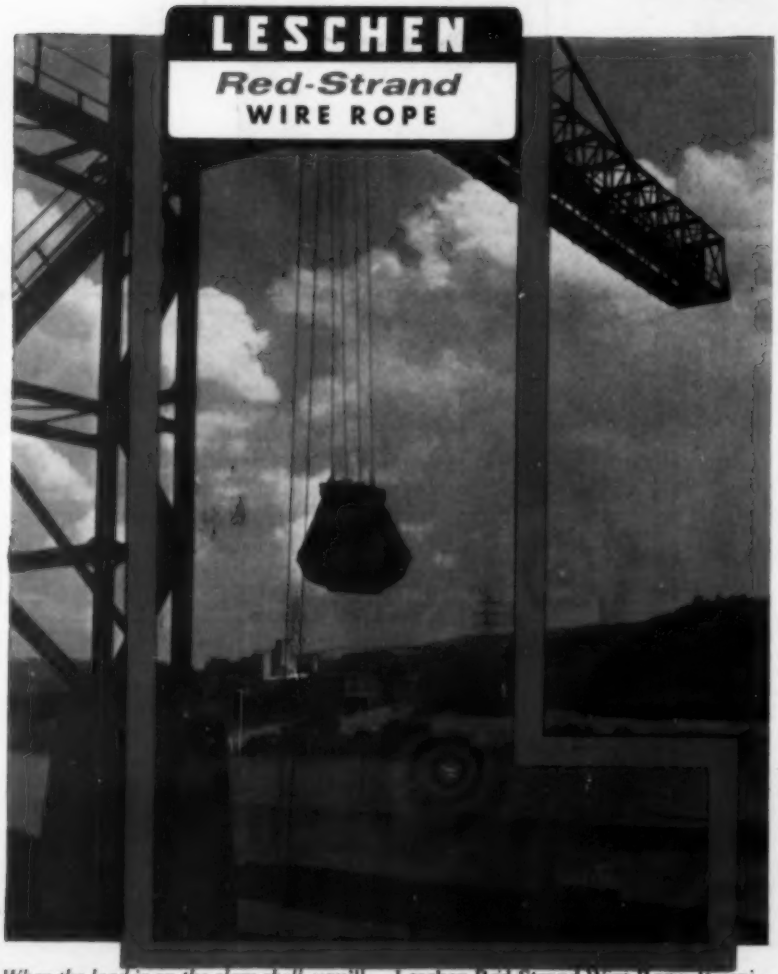
when the going gets rough—

give 'em "L"



When the load is on the clam shell, you'll be glad you rigged with *Leschen*—the wire rope that's the same top quality in every foot of every reel. At Leschen there are new machines with exclusive new continuous-flow technique. Try Leschen Red-Strand Wire Rope. Its uniform quality makes your operation safer, your replacement time farther in the future. *Leschen Wire Rope Division, H. K. Porter Company, Inc., St. Louis 12, Missouri.*

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H.K. PORTER COMPANY, INC.

PORTER SERVES INDUSTRY: with Rubber and Friction Products—THERMOID DIVISION; Electrical Equipment—DELTA-STAR ELECTRIC DIVISION, NATIONAL ELECTRIC DIVISION; Copper and Alloys—RIVERSIDE-ALLOY METAL DIVISION; Refractories—REFRACTORIES DIVISION; Electric Furnace Steel—CONNORS STEEL DIVISION, VULCAN-KIDD STEEL DIVISION; Fabricated Products—DISSTON DIVISION, FORGE AND FITTINGS DIVISION, LESCHEN WIRE ROPE DIVISION, MOULDINGS DIVISION; and in Canada, Refractories, "Disston" Tools, "Federal" Wires and Cables, "Nepcoduct" Systems—H. K. PORTER COMPANY (CANADA) LTD.

says W. S. Landers, superintendent of the Denver Coal Research Lab of the U. S. Bureau of Mines.

Mr. Landers told the Missouri Basin Interagency committee that hydro-power will provide only about 17% of the estimated power needs of the 10-state Missouri Basin by 1970. He said coal is the potential source of additional power for the area and that 41% of the nation's coal reserves are in the Missouri River Basin, most of it low-grade.

The Wyoming and Utah districts of the United Mine Workers have protested the proposed Burns Creek project in eastern Idaho.

The union complained the project would interfere with Utah Power & Light Co.'s proposed $34 million steam power plant on the Hamsfork River, near Kemmerer, Wyo. Utah Power's plant would use coal from Kemmerer Coal Co. mines.

The Youngstown Sheet & Tube Co. announced it has awarded a contract for the rebuilding of 84 coke ovens at its Brier Hill Works, in Youngstown, Ohio.

Allied Chemical's Wilputte Coke Oven Div. was the contract recipient. Expected completion is by April, 1960.

Interlake Iron Corp. announced it will build a 3,000-ton sintering plant at its Chicago merchant pig iron producing facilities.

When the new plant's design capacity of 3,000 gross tons a day is reached self-fluxing sinter is expected to comprise between 80 and 90% of the total blast-furnace burden. Coke, which provides fuel for the process, will be fed directly into the plant from a new screening station. Dravo Corp. is the general contractor.

Labor

The Wyoming Supreme Court has ruled that state courts have jurisdiction to grant an injunction to halt picketing at a Carbon County, Wyo., coal mine.

The Court reversed Dist. Judge Vernon Bentley's decision that the state court had no jurisdiction when Hanna Basin Construction & Coal Co. asked an injunction to prevent the UMW from picketing its strip coal mine at Elmo, Wyo. The case was remanded to the Carbon County district court with instructions that the court assume jurisdiction and decide the issue.

Safety

A Jeffrey Mfg. Co. Colmol was cred-

It's PRESTRESSED!

Quaker Thermoid Conveyor Belting keeps rolling with the punches

Before it ever comes to you, the heaviest tension you'll put on Thermoid-Quaker Conveyor Belting has already been built in—and then released *after* curing. So the rubber and fabric are really in *compression* when you put the belting to work—ready for the toughest pull without overstraining the yarn or the cover.

There's a Thermoid-Quaker belting designed with just the combination of properties you need for each conveying job. To get the right belting for *your* needs, talk with the Thermoid industrial distributor nearest you, or write to *Thermoid Division, H. K. Porter Company, Inc., Tacony & Comly Sts., Philadelphia 24, Pa.*

Notice how the special "Coledge" construction of Thermoid-Quaker Belting provides greater flexibility at the edges—more shock-absorbing rubber where the worst beating occurs.

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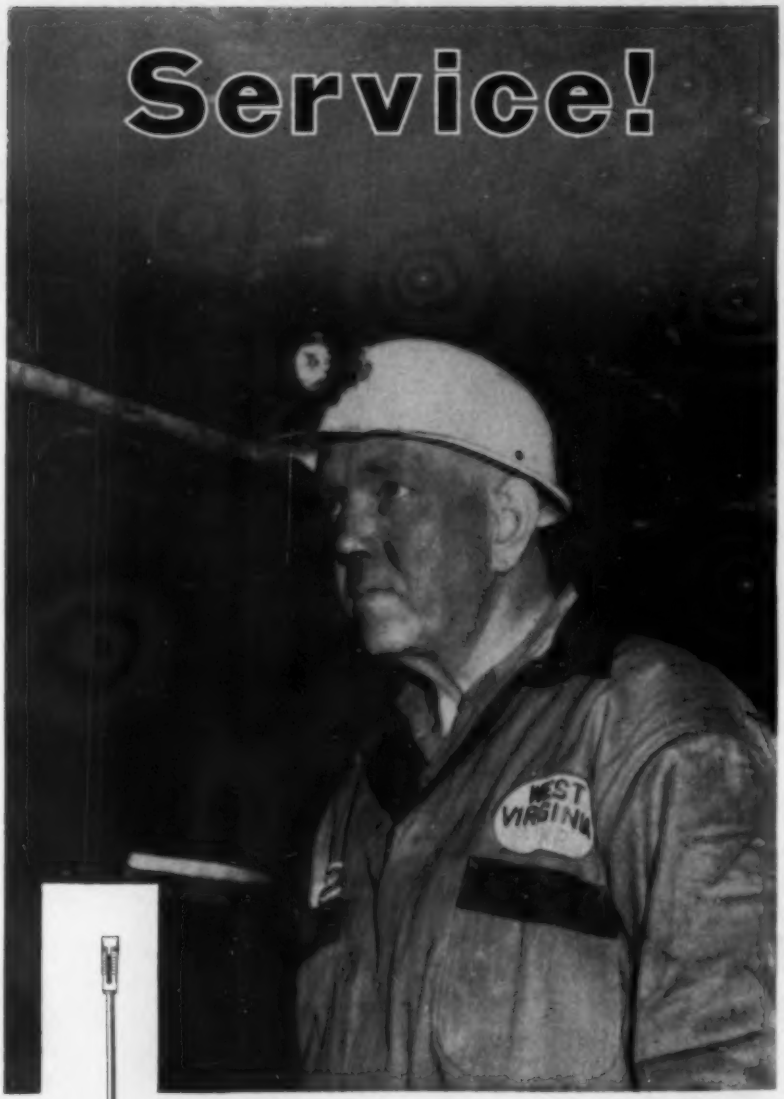

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Need assistance in solving difficult roof-bolting problems? Want maximum safety, easier installation and prompt deliveries of roof bolts? Write Connors Steel Division, P. O. Box 158, Huntington, West Virginia or call JAckson 9-7174 for service you will like . . . quality you can trust.

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News Roundup *(Continued)*

ited with saving the lives of three coal miners trapped for 41 hr at the Ken Mine of the Peabody Coal Co., Beaver Dam, Ky.

The Colmol, working under severe conditions, took only 25 hr to open a 395-ft passageway through rock and coal until the entry was made to the trapped men 450 ft down. Earlier attempts to reach the men had failed.

Harmar Coal Co.'s Harmar mine came in first in the Allegheny-Kiski Safety & First-Aid Association meet held June 13 at Springdale Athletic Field, Springdale, Pa.

This was the 18th annual contest held by the group.

Meetings

Gordon Research Conference, June 15 to Sept.—Colby Junior College, New London, N. H., New Hampton School, New Hampton, N. H., and Kimball Union Academy, Meriden, N. H. Lectures and conferences to stimulate research in science.

The Council of Underground Machinery Manufacturers, Mining Machinery Exhibition, July 9-18—Grand Hall, Olympia, London, Eng. Includes display of mining equipment made during last decade.

International Briquetting Association, Briquetting Conference, August 24, 25 and 26—Glacier Park Lodge, Glacier Park, Mont.

Short Course in Coal Mining, 47th annual meeting, July 6-28—School of Mines, West Virginia University and Mullens, W. Va.

Electricity and Equipment Maintenance Short Course, 7th annual meeting, July 6-28—Gary High School, Gary, W. Va., and Shinnston Grade School, Shinnston, W. Va.

Exploration Drilling Symposium annual meeting, Oct. 8-10—Penn State University, University Park, Pa. Sponsored by mining departments of Penn State, Colorado School of Mines and the University of Minnesota.

American Institute of Mining, Metallurgical & Petroleum Engineers, Inc., annual meeting, Feb. 14-18, 1960—New York, N. Y.

American Mining Congress, Coal Div. meetings—Huntington, W. Va., Aug. 11-13; Evansville, Ind., Aug. 25-27; Terre Haute, Ind., Aug. 28. Themes include haulage, roof control, etc.

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CONSISTENT PERFORMANCE...
MAXIMUM SERVICE...

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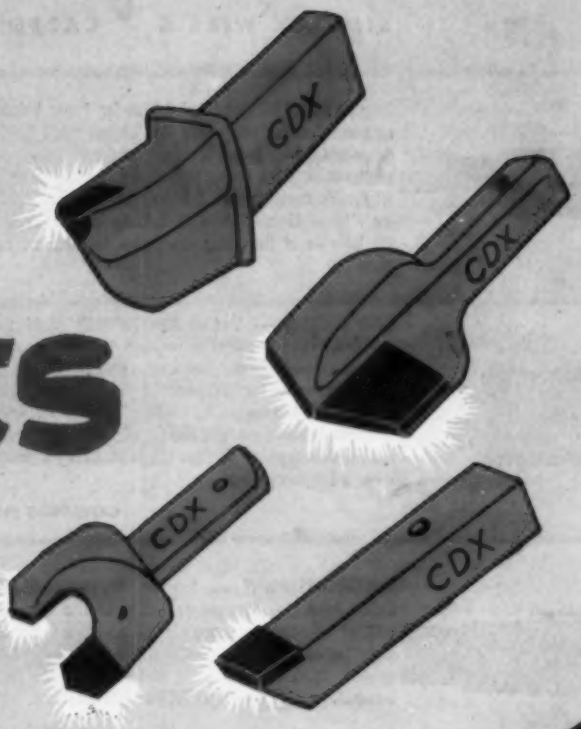
carbide-tipped **bits**

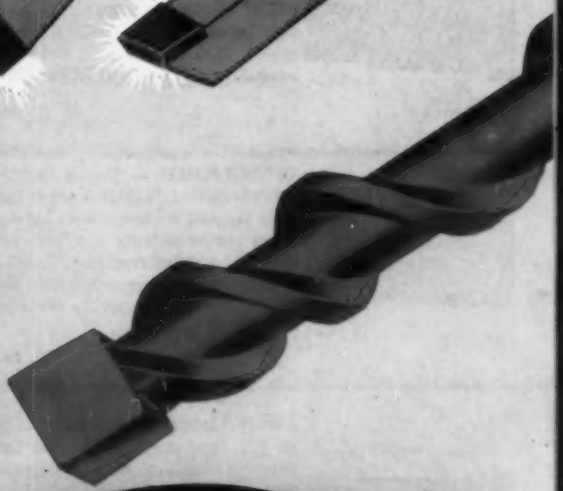


Job-proven to give you *more* . . . in production, performance and service! In "show-down" tests in mine after mine, Cardox bits maintain a lower "cost-per-foot cut or drilled" rating than any other. It's no secret why . . . Cardox carbides are job-matched to meet your specific mining requirements, whether it be drilling or cutting. They are made to uniform quality standards . . . bit after bit, they deliver the same consistently high production output, the same long service life. They make continuous mining more continuous. Want proof? We'll be glad to run a test at your mine. You name the time, place and conditions. Bits available in all sizes and styles.

and

heat-treated alloy steel

augers



The all-new Cardox roof auger gives you 2-to-1 peformance over all others. Strong, rugged, long-lasting . . . Cardox roof augers are constructed of tough alloy steel, welded—then heat-treated for added strength and abrasion resistance. An extra pitch of flight at the shanks end provides added strength at the point of stress. In standard lengths from 10" on up; other Cardox augers are available from 1¼" to 48" in diameter. Same high quality, same high performance.

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You can rely on Airdox-Cardox for straight practical answers to your mining problems. We offer you a unique combination of experience, know-how, broadest distribution and stocking facilities, and available qualified underground personnel to answer your needs efficiently, effectively and economically. Call on us . . . where there's coal, there's . . . AIRDOX-CARDOX!

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Phone: Benton 8-3821

Pikeville, Kentucky
Route 2, Box 571
Phone: Robinson Creek 13

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Simplex PRODUCTS GUIDE

SIMPLEX WIRE & CABLE CO., CAMBRIDGE 39, MASSACHUSETTS, U.S.A.

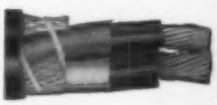
Simplex ANHYDREX Insulated Cables for Power transmission and Communication (like the Simplex TIREX Portable Cords and Cables shown in adjacent column), though manufactured as stock products, are custom designed to suit all service requirements. A large technical and engineering staff at Simplex' main plant is equipped to give you the benefits of their long experience in electrical cable planning.

ANHYDROPRENE — Simplex ANHYDROPRENE Cables are designed for economical installation in ducts, conduits, racks, trays and raceways. Stock sizes AWG 14 to 1000 MCM are recommended for 90 C service in WET or DRY locations. The words "Simplex ANHYDROPRENE" are either printed or molded plainly on the jackets of all ANHYDROPRENE cables. This marking signifies the traditionally high quality of a Simplex product.

CATALOGUE #1028

ANHYDREX-NEOPRENE — Simplex ANHYDREX-NEOPRENE Cables have the added mechanical protection of a heavy wall of neoprene jacketing. These cables are manufactured for use in aerial installations and for direct burial service. Stock sizes AWG 14 to 1000 MCM are recommended for 90 C service in WET or DRY locations.

CATALOGUE #1028



ANHYDREX-PLASTEX — Simplex ANHYDREX-PLASTEX (ANHYDREX-insulated, PLASTEX-jacketed) Cables are scientifically designed for compatibility between insulation and jacket, and for perfectly balanced performance in ducts, conduits, aerial and direct burial installations. ANHYDREX-PLASTEX Cables are recommended for service in a number of environments but especially where oils and chemicals are a problem.

CATALOGUE #1028

ANHYDREX Insulated Control Cables — Simplex ANHYDREX Control, Signal and Communication Cables have an additional thickness of appropriately coded neoprene over each individual conductor, plus heavy-duty neoprene jackets. ANHYDREX insulation provides excellent signal reproduction and is exceptionally stable, even when operating with high ambient temperatures.

CATALOGUE #1028

ANHYDREX XX — Simplex ANHYDREX XX is a butyl-based insulation of the highest possible quality. Because of its exceptional resistance to heat and ozone, it has general applications in circuits operating up to 35,000 volts, with permissible conductor temperatures of 90 C. to 5KV, and 85 C to 17KV — in wet or dry locations.

CATALOGUE #1023

CONDEX — Simplex CONDEX Cables are protected against mechanical damage by interlocked metallic armor. The armor is manufactured of galvanized steel, plain or baked enameled (colored) aluminum, bronze or other metals, and can be applied over any cable core within a very wide diameter range. CONDEX Cables may be further protected by a thermoplastic covering over or under the metallic armor.

CATALOGUE #1024

TIREX SO and SJO Cords — TIREX SO and SJO Cords constructed to meet the most rigid specifications. Al their special features are carefully selected and proce to give maximum qualifications for portable service. will twist without kinking, and bend without brea TIREX stranding affords maximum flexibility without s ficing strength.

Conductor temperature rating 75c

CATALOGUE

TIREX Low Voltage Portable Cables — TIREX Low Vol Cables are individually designed for specific applicat They are practically indestructible when used to d work for which they are intended.

Conductor temperature rating 75c

CATALOGUES #992 &

TIREX High Voltage Portable Cables — TIREX High Vol Portable Cables have unequaled strength and versa Designed primarily to transmit energy to mobile elec equipment, they are also used as temporary power during alterations or emergency repairs.

Conductor temperature rating 75c

CATALOGUE

TIREX Mine Locomotive Cables — TIREX Mine Loco Cables — both single and two-conductor concentri approved by the Bureau of Mines and have the raised ing "P-101 BM" on their heavy-duty neoprene jacke TIREX Cables are cured and conditioned for service

Conductor temperature rating 75c

CATALOGUE

TIREX Mining Machine and Shuttle Car Cables — Mining Machine and Shuttle Car Cables are designe stability under today's rigorous mining conditions. T sulated conductors are "ribbed" or gear-shaped. Thi ture causes them to interlock with the heavy duty neo jacket and prevents them from slipping. Both Type Type G have "P-101 BM" molded onto the jacket.

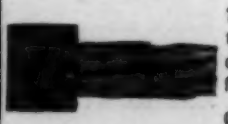
Conductor temperature rating 75c

CATALOGUE

TIREX Dredge and Shovel Cables — TIREX Dredg Shovel Cables are masterpieces of engineering ac ment. Every consideration has been given to safet durability. Simplex special cured-in-lead neoprene effectively resists all the elements normally encou in this type of work.

Conductor temperature rating 75c

CATALOGUE



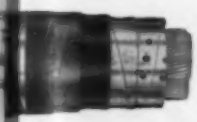
TIREX Welding Cables —TIREX Welding Cables are tifically stranded for maximum flexibility without drag. Cured-in-lead neoprene jackets provide utmost for both operator and bystanders.

Conductor temperature rating 75c

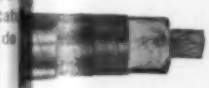
CATALOGUE

AND CATALOG REFERENCE

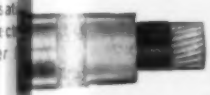
Please address requests to the Simplex home office in Cambridge or to your nearest Simplex district office.



Simplex Paper Insulated Cables — Simplex Paper Insulated Cables are individually designed for specific jobs. They are available as either single or multiple conductor cables. The stranding may be round, segmental, sector or compact. Lead sheaths, reinforced neoprene jackets, or combinations of these are available for protection against moisture.

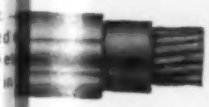


Simplex Polyethylene Insulated Cables — The versatility of Simplex Polyethylene has increased tremendously during the last ten years. Research has adapted it, not only to control and communication circuits, but also for power applications up to 35,000 volts. Our experience in this specialized field is unmatched by any other cable manufacturer.

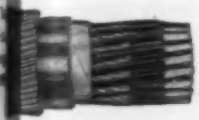


Simplex SIMCONEX Insulation — SIMCONEX (Simplex silicone) Insulated Cables are specially designed for service where unusual extremes in operating temperatures prevail. SIMCONEX may be specified on all types of power, control, and communication cables. It is practically immune to ozone and corona and, with its temperature rating of up to 200 C for certain applications, it has the greatest resistance to heat of any known thermosetting insulation.

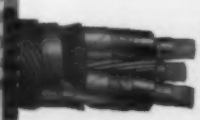
CATALOGUE #1032



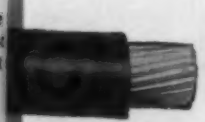
Diesel Locomotive Cables — Diesel Locomotive Cables are specially insulated and jacketed for 90 C service in the following applications: generator leads, motor leads, power jumpers, control jumpers, lighting systems, headlight wire, controller wiring, and cab signal wire. Highly flexible stranding promotes easy installation.



Antimicrophonic Cables — Simplex Antimicrophonic Cables are adaptable wherever extremely fine measurements are to be made. They will not produce spurious voltages when compressed, deformed or subjected to violent shock. Can be manufactured with a varying number of conductors and conductor sizes.



Bore Hole and Shaft Cables — Bore Hole and Shaft Cables are generally insulated with Simplex ANHYDREX moisture-resistant insulation. Mechanical protection is provided by galvanized or stainless steel, copper, copperweld or other appropriate round wire armor. PLASTEX jackets may be specified over or under the wire armor.



PLASTEX Apparatus Wire — Simplex PLASTEX Apparatus Wire — for machine tool, switchboard wiring and other similar applications. Simplex PLASTEX is available to meet a wide range of operating temperatures.

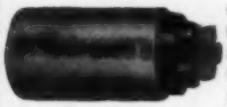
C-L-X Sheaths — Simplex C-L-X is a continuously corrugated, pliable, lightweight, exterior metallic cable sheath which is impervious to gases, chemicals, and water. Its unique construction makes it adaptable to nearly all environments or services and gives it a combination of properties unmatched by any cable system now manufactured. C-L-X is appropriately called "the metallic duct with built-in cable."

CATALOGUE #1031

ANHYDREX Submarine Cables — Simplex ANHYDREX Submarine Cables for power, control and communication circuits are designed from experience dating back to 1920. (The moisture resistance of ANHYDREX made possible the first nonleaded submarine cables.) High tensile strength armor wires of steel or other appropriate metals provide the best possible mechanical protection.

Self-Supporting Aerial Cables — Simplex Self-Supporting Aerial Cables for power, control and communication circuits practically eliminate the necessity of tree trimming. They are completely assembled at the factory and ready for installation. Because of this, they are extremely easy to handle and cut installation cost to a fraction of what it would normally be.

CATALOGUE #1006



Lead Covered Cables — When a customer's specifications demand a lead sheath, Simplex has full facilities for its manufacture. A number of high-grade lead alloys are available including tellurium, copper bearing and arsenical. Recent studies enable Simplex engineers to recommend the most appropriate lead sheath alloy for your particular application.

Railroad Signal and Communication Cables — Railroad Signal and Communication Cables may be insulated with either ANHYDREX or Polyethylene, with mechanical protection, according to individual needs. Bronze tapes are usually provided in direct burial constructions.

Cathodic Protection Cables — Cathodic Protection Cables are used to equalize voltage potential between metallic structures and the earth. Simplex ANHYDREX or Polyethylene insulations may be specified with complete confidence.

CATALOGUE #1033

Simplex Varnished Cambric Cables — Simplex Varnished Cambric Cables are particularly suited for station or power house wiring, or for any service where the operating temperature is high. Between each layer of varnished cambric is a plastic filler compound which is nonhardening, and nonmigrating. It allows the tapes to slip one upon the other without danger of wrinkling.

BULLETIN #108

NOW...a year later...same 9
still leads in availability
...with 96.1% working record

—for Southern California Edison Co., Los Angeles, Calif.

A year later, in 1959, still meeting and beating machine-mauling High Sierra rock-hauling conditions—on Mammoth Pool Hydroelectric Project, for Southern California Edison—the same 10-unit International 95 Payhauler fleet is still turning in this excellent record of availability.

With 2,500 to 2,700 working hours clocked on each unit of the fleet, the 10 Payhaulers delivered 96.1 availability in a recent measured month. The Payhauler fleet never lost a day due to mechanical failure! Performance like this has helped advance job-completion date substantially ahead of schedule!

Southern California Edison Company credits their excellent results partly to strong-built, easy-to-maintain machines—partly to a methodical preventive maintenance program. Working view shows two Payhauler units highballing rock fill to the dam site in 1959—maintaining record high availability!

...NEW corrugated-body Payhauler models sp

New "95" Payhauler gains 3 tons in capacity, plus an additional 40 diesel hp.—with new corrugated body design and new 375-hp. turbocharged International DT-817 diesel engine.

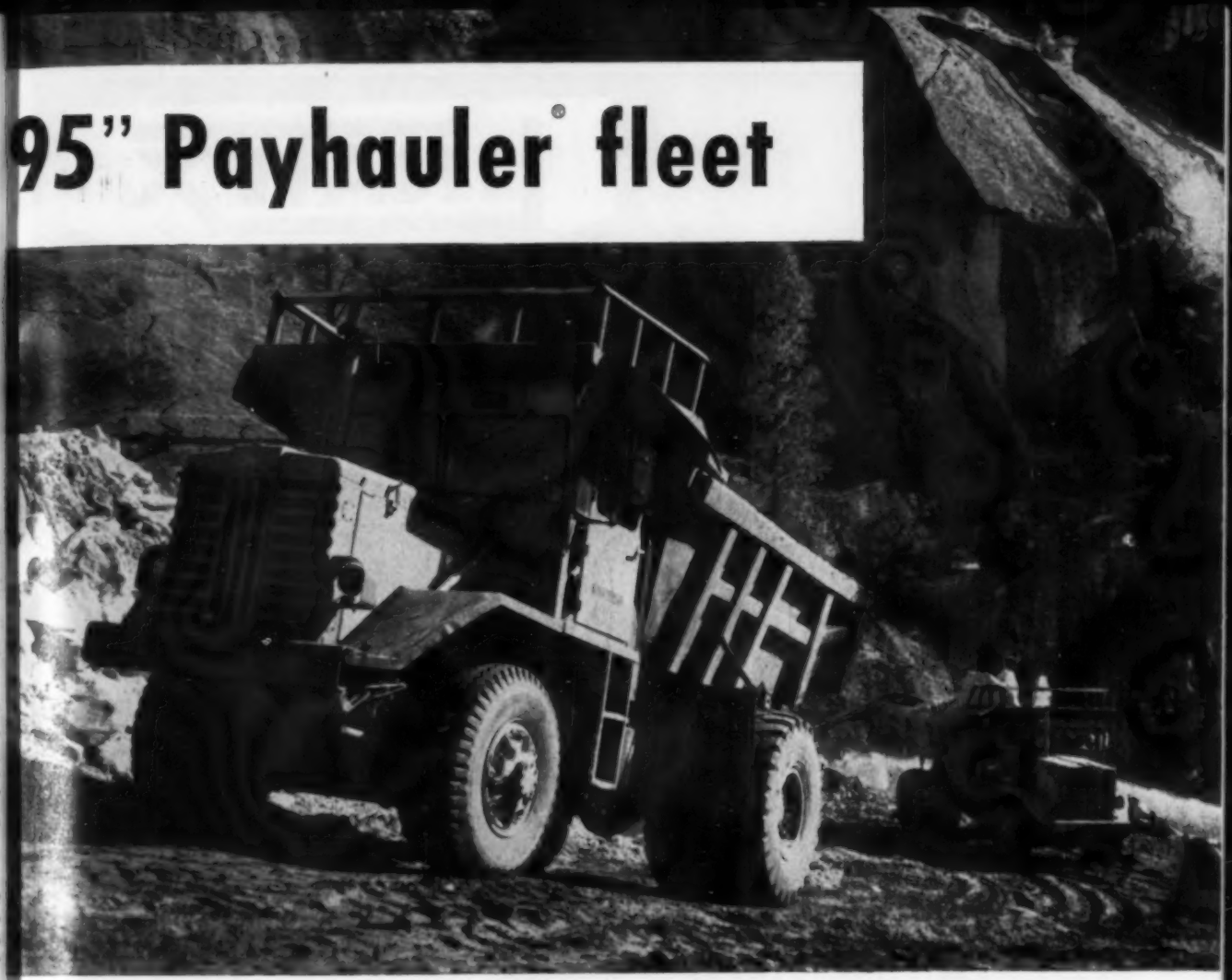
See those exclusive, rock-ribbed body corrugations! International applies this exclusive strength-multiplying principle to reduce the body-weight of new Payhauler models with these results:

- **New "95" Payhauler loses 2½ tons of power-wasting dead-weight; gives 3 extra tons of payload capacity!**
- **New "65" Payhauler sheds 5,000 pounds of useless "ballast"; gains a whole ton of new hauling capacity!**

And both these weight-streamlined Payhaulers have new International diesel power to highball the bigger payloads 14% faster than the previous models. These new Payhauler models have the power-to-weight ratio to out-cycle even lower capacity rigs.

Get the proof that new Payhauler models can deliver and keep delivering you the lowest material-moving costs in the off-highway hauling market. See your International Construction Equipment Distributor for a demonstration!

95" Payhauler® fleet



speed bigger loads...up to 14% faster!

New "65" Payhauler, the only 19-tonner, features International's *exclusive* new corrugated body principle. Powered by the naturally aspirated new 250-hp. International D-817 diesel engine.

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International Harvester Co.
180 N. Michigan Ave., Chicago 1, Ill.

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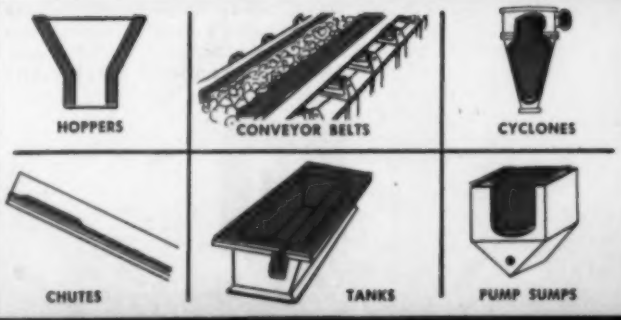

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Devoted to the Operating, Technical and Business Problems of the Coal-Mining Industry

COAL AGE

JULY, 1959

IVAN A. GIVEN, EDITOR

Better Instruments

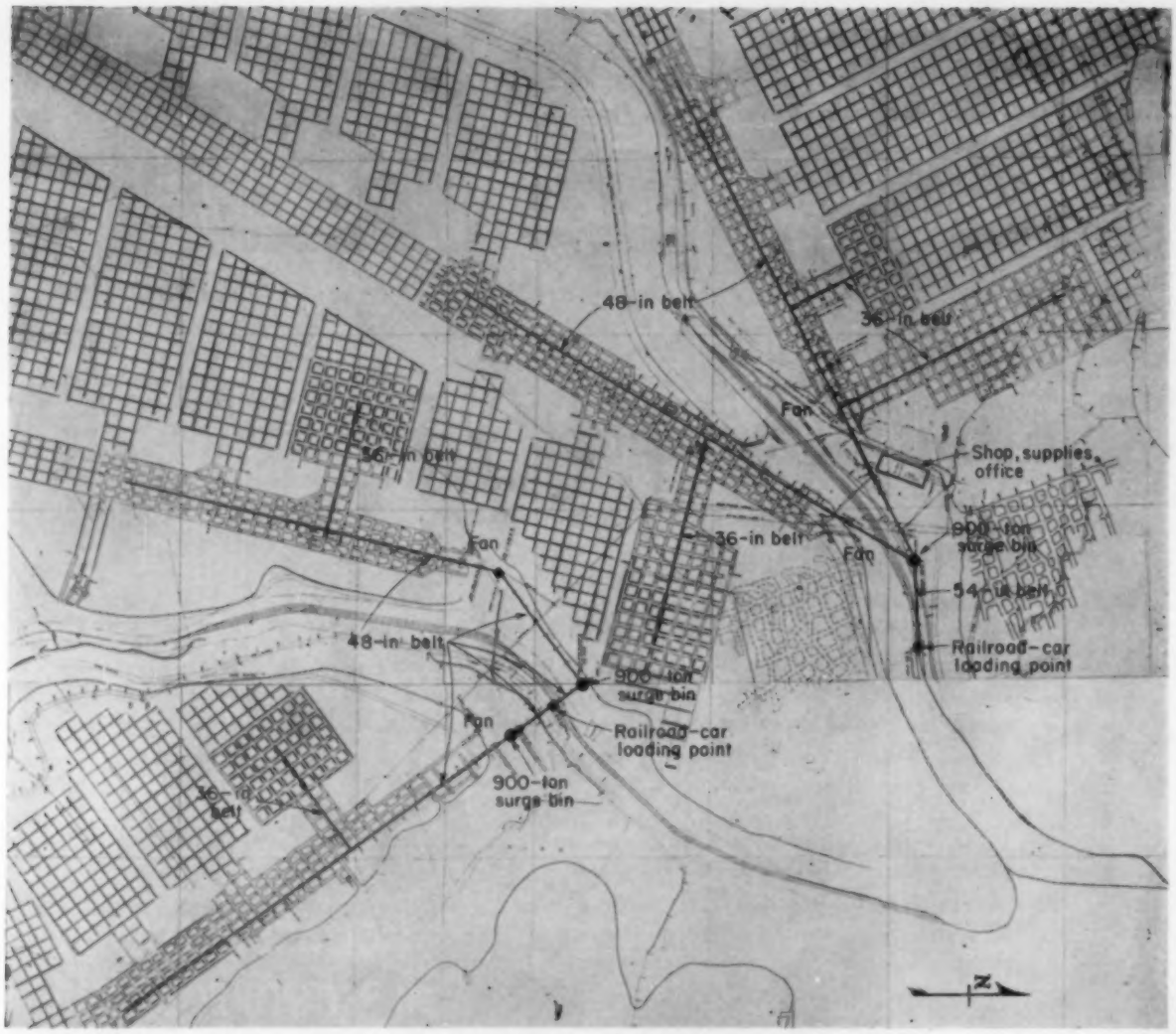
Forging new organizational instruments with the aim of improving its position in the market place, in legislative and administration quarters, and in the public view has been a major bituminous activity in the past few months. Latest step was formalization of changes in the structure of the National Coal Association with the particular goal of combination with or absorption of other organizations to bring added strength to bear in attaining the industry's objectives in the immediate future and the days farther ahead.

Major reorganizations are, of course, not easy to achieve. Among other things altering the established order, no matter how carefully done, involves personalities and accentuates differences in thinking on objectives and procedure—at least for a time. The bituminous reorganization now in process is no exception to this long-standing rule.

Policy is of course first in line among the issues. Just what should it be? Some in bituminous, for example, while conceding the seriousness of the problem, have reservations concerning coal's campaign to blunt the force of competition by having it regulated, holding, among other things, that it puts coal in a poor light in addition to establishing a principle that can be used as a basis for regulating coal in turn at some future date—perhaps not too far off. Some hard thinking, they contend, must still be done on certain subjects.

Then there is procedure and the kind of a machine that should be created to effectuate the policy eventually decided upon. Again, some in coal wonder if an organization can take on such diverse activities as engineering service on the one hand and representing the industry before Congress on the other and do justice to both. In contrast there are those who believe that even greater concentration of activities under one roof is the better approach.

All these and other questions are the normal accompaniment of a major reorganization. But clear, objective, workable policy is concededly a highly desirable goal. Equally necessary is an effective organization or organizations to insure that the policy is translated into legitimate progress for the industry. Merely maintaining the status quo is not the answer. Rather it is the dynamic approach even though it brings up the problems previously noted and others as well. But if the result is a better set of instruments and consequently a better tomorrow for coal the effort is clearly worth the making.



MINE LAYOUT includes four portals, each of which will soon produce 3,500 tons per shift. Coal flows to surface over network of 36- and 48-belts. Complete extraction of pillars is planned in block sistem.

Specially designed equipment enables section crews to mine up to 1,500 tons per shift from 10- to 18-ft seam. Production target for end of year is 22,000 tons of clean coal per day from $30,000,000 operation now producing 15,000 tons in two-shift operation.

SPECIALLY DESIGNED equipment capable of working efficiently in coal 10 to 18 ft thick is important factor in producing up to 1,500 tons per shift per section.

A AND B PORTALS feed coal to a common 900-ton storage bin for delivery by belt to 70-ton railroad cars.

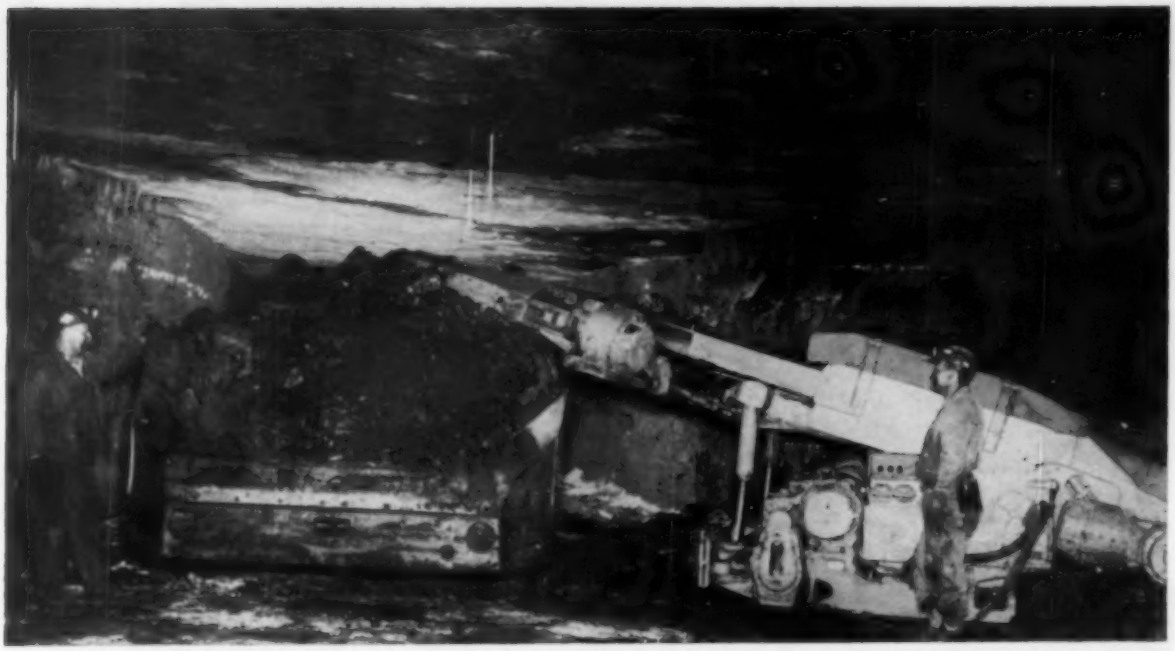
C AND D PORTALS deliver coal to separate 900-ton bins. Two belt conveyors then carry coal to common loading point.

Moss No. 3: Clinchfield's Bid For World's Largest Mine

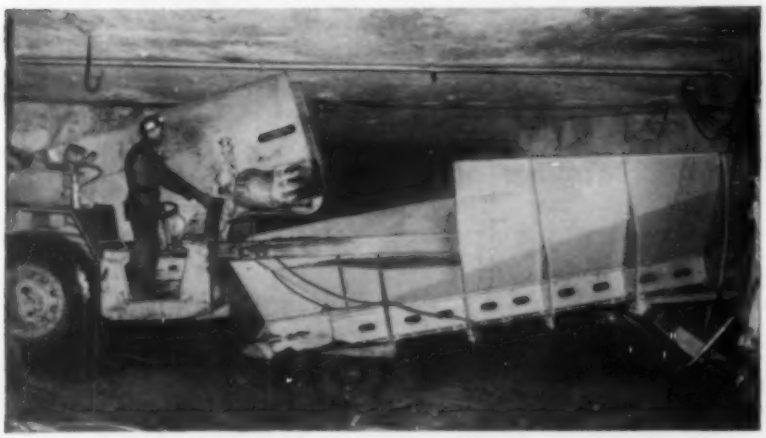
FIVE MILLION TONS of clean coal per year—produced by equipment tailored especially for the 10- to 18-ft thick Tiller seam and prepared at the rate of 1,500 tph in one of the largest and most highly automated plants of its kind in the world—is the production goal of Clinchfield's giant Moss No. 3 mine. Clean coal now flows to railroad cars at the rate of 12,000 to 15,000 tons on a two-shift schedule. By the end of 1959 Clinchfield expects to be operating Moss No. 3 three shifts and producing 20,000 to 22,000 tons of clean coal per day from the $30,000,000 operation.

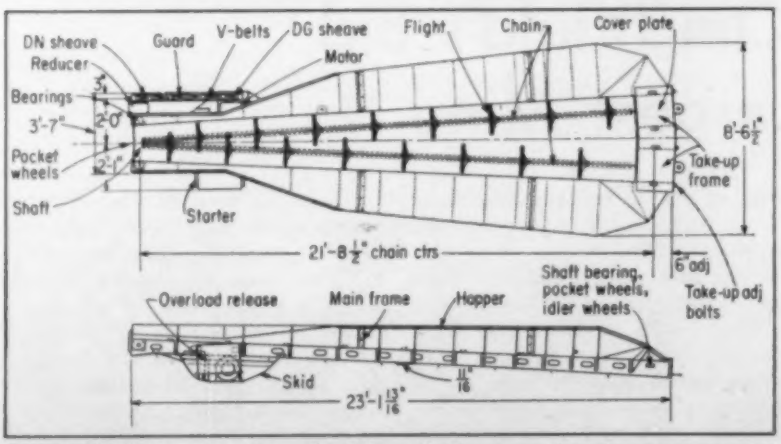
Moss No. 3 produces coal with specially designed equipment enabling section crews to mine up to 1,500 tons per shift. Coal flows over a network of 36- and 48-in belt conveyors from four portals to two railroad-car loading centers at the mine. It then travels overland 8 mi by railroad to a central unloading point at the No. 3 preparation plant, at Carbo, Va. There coal is unloaded at the rate of one car every 45 sec, and started on its way to a 2,500-ton raw-coal storage bin feeding two in-plant storage bins. These bins feed to four identical circuits in the preparation plant.

Coarse coal passes through two stages of dense-medium washing,



HIGH-CAPACITY LOADER tailored to Moss No. 3 conditions gathers coal at the rate of 15 tpm. Two cars serve loader.





BELT FEEDER receives 13-ton load from shuttle care in less than a minute and discharges it at slower rate to belt. Unit is started by driver, stops automatically.

where the raw product is separated into metallurgical and steam products. The first stage takes off the "cream," a high-grade metallurgical coal with 5% ash, less than 0.6% sulphur, 28% volatile matter, No. 9 coke button and 2,600 F fusion temperature. The second washing yields a steam coal which moves by rail to the Appalachian Power Co.'s Clinch River power plant 3 mi from Carbo.

Fine coal is washed on double-deck tables which also make a three product separation: metallurgical coal, steam coal and refuse. Ultrafines are recovered by froth flotation.

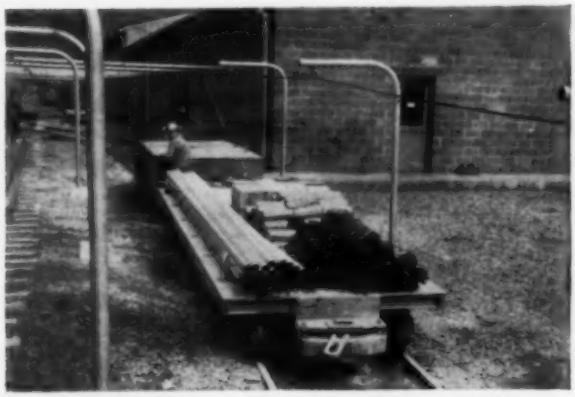
Moss No. 3 operations are in the thick Tiller seam which occurs in the Norton formation of the Pennsylvanian series where the No. 4, or Tiller, and No. 5, or Jawbone, coals are so close together they form one seam 10 to 18 ft thick. Normally the two beds are 75 ft apart.

The area allocated to Moss No. 3 covers 15 sq mi and contains 100,000,000 tons of coal. It lies under Sandy Ridge which rises 2,500 to 3,300 ft above sea level at its crest and forms the boundary between Dickenson and Russell counties, Va.

The coal outcrops only in Dickenson County near Duty, which was a sparsely populated community 4 mi from the nearest hard-surfaced road before the new mine was opened.

ROPE-FRAME BELTS provide smooth ride for coal as it travels from producing sections to portals.

SKID-MOUNTED transformer and air compressor are conveniently located near each panel belt drive.



MINE SUPPLIES, including aluminum pipe, roof bolts and rock dust, are carried to the working areas on special flat cars.

Lack of telephone service, bridges with only 5-ton capacity and single-phase rural power added to the development problems.

The large capital expenditure that would be required for railroad facilities to reach the coal outcrop demanded a large capacity operation. From Clinchfield's viewpoint on profit requirements, at least half of the production would have to be sold on the metallurgical market. Because of the anticipated high quality of the metallurgical product no difficulty was anticipated in selling this fraction. The major sales problem, therefore, appeared to be finding a market for the steam-grade product.

Early in 1956, however, Appalachian Electric Power announced plans to build a 450,000-kw coal-fired power plant near Carbo. To provide steam for the generators would require 1,200,000 tons of coal per year. To meet the needs of the new power plant, development of Moss No. 3 not only became possible but necessary.

Clinchfield's Top Management

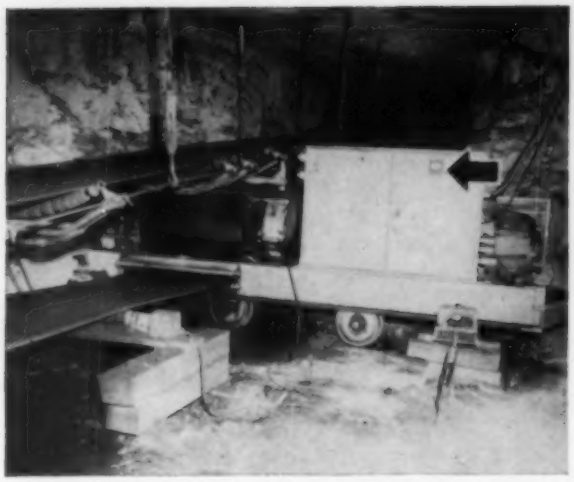
R. H. Hughes, president
H. W. Livingston, vice president
C. K. Tieche, vice president, operations
O. N. Hall, comptroller
F. M. Morris, chief engineer
R. T. Huffman, production manager
J. K. Berry, assistant to vice president, operations
R. J. Howard, mining engineer
R. E. Joslin, preparation manager
E. E. Stepp, production engineer

Initial mine capacity was pegged at 15,000 tpd of clean coal on a two-shift schedule and Carbo was chosen as the site for the preparation plant. This site offered a number of advantages and was a natural choice because there was little flat land at the coal outcrop at Duty, no water, and refuse disposal would have been a problem. At Carbo, however, Clinchfield owned a suitable site with room for expansion, a good water supply, adequate refuse-disposal area, existing railroad facilities and close to the Appalachian Power's new plant site.

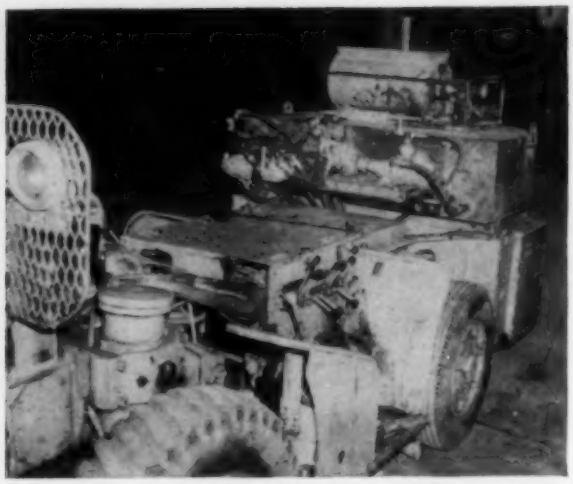
To link the mine portals with the preparation plant required construction of 31 mi of track and driving an 8,240-ft tunnel through Sandy Ridge. Of the 31 mi of track, 8 link the cleaning plant and mine, 16 are at the mines and 7 connect the two car-loading points at the mine. Total cost of the track and tunnel add up to $13,500,000 and cost of rolling stock will ultimately reach $40,000,000.

Preliminary Testing and Mining

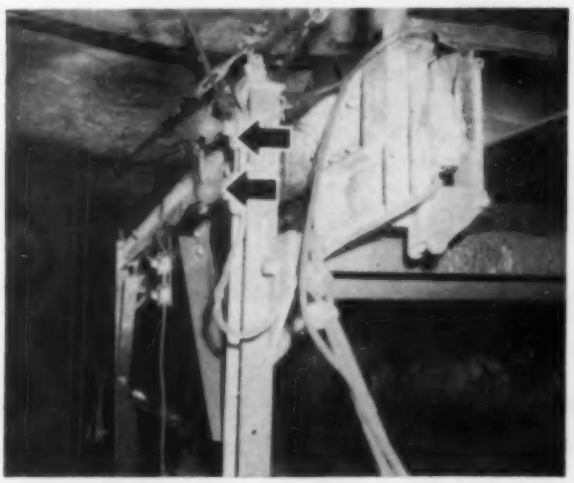
To supplement original information about the coal seam that had been acquired by prospecting and core drilling in 1920, Clinchfield checked several truck mines in the general area where the new mine opening was planned. These openings provided valuable information on floor conditions and behavior of pillars, and also were a source of samples.



BUILT-IN AMMETERS on belt drives indicate motor loads and enable supervisors to spot any unusual buildup of load.



SAFETY FEATURES added to universal cutters include spray system for allaying dust and wet rockduster.



PROTECTIVE DEVICES on belts have red and green lights that help maintenance men locate trouble quickly. Misalignment switch (right) protects belt from edge wear.

In 1954, Clinchfield bought several thousand tons of the lower bench coal from truck operations and sent it to the Moss No. 1 preparation plant. Washing results showed 4½% ash and 0.6% sulphur. Carbonization tests on the clean coal indicated that the coal coked strongly but was nearly neutral in expansion.

In 1956 the company started an intense program of prospecting and testing, including facing up the outcrop, core drilling and experimental mining. In addition, Clinchfield made a number of washability and carbonization tests.

Coal from an experimental mine was fed over a vibrating screen to get an estimate of the size consist of raw coal that would be delivered to the proposed preparation plant. In this series, the company obtained valuable information on coal produced by full-seam mining.

Nine months of test mining provided the following facts about mining conditions: firm shale roof; coal thickness of 10 to 18 ft, often with less than 1 ft of parting; and an increase in seam impurities with an increase in seam thickness. Impurities varied from hard rock up to 30 in thick to a similar thickness of soft, crumbly shale.

Washability tests on the full seam indicated 65% coal recovery, of which 75% would be 5½% ash and 25% would be 12 to 14% ash. Carbonization tests produced a slightly contracting coke.

Special Mining Equipment

Management's original idea on how to mine the 10- to 18-ft coal was to use conventional equipment in full-seam mining. Nothing happened during the experimental mining to indicate that the conventional machines could not do the job if they were rugged and had sufficient capacity. As a result, the company began negotiations with the manufacturers to get equipment capable of producing 1,500 tons of raw coal per shift with a 10-man crew.

Management was satisfied that the

Joy 10-RU cutter could handle the cutting job and the 15-SC shuttle car would be suitable for section haulage. One of several self-propelled coal drills could be employed. Thus the main problem was to get a rugged high-capacity fast-tramming loader. Joy undertook the job of building a loader to Clinchfield's specifications and came up with the 15-BU.

Clinchfield set up the following specifications for a roof-bolting unit: a solid working platform for two men; built-in adjustable safety jacks to protect the men while bolting openings 8 to 18 ft high; and adaptability to being leveled, trammed or held on a 15% grade. Acme Machinery Co. came up with a self-propelled rubber-mounted unit that met the company's needs.

Opening the Mine

To insure that the ultimate output —20,000 to 25,000 tons of clean coal per day—could be mined with a minimum of effort, top management decided to tap the seam at the outcrop with four portals. Two openings were projected on Cane Creek and two on Tiller Fork. Plans called for the portals to be on opposite sides of the two streams.

Management first considered big mine cars, 30-ton or better, for haulage, but the dip of the coal ruled out track haulage except in mains on the strike. Lateral haulage would have to be belts. A legal haulage problem on Cane Creek made it impossible to project the main haulage in one portal on the strike. Consequently, it had to be laid out on a 6% downgrade, which demanded a belt conveyor.

Since the company wanted to standardize equipment and methods, all-belt haulage was chosen for all openings. Rope-frame units were chosen for all underground conveyors to cushion the lumps of coal and rock the company expected from the thick seam. Goodman 48-in units powered by 150-hp 440-V dual-motor drives carry coal in all mains and Jeffrey and Joy 36-in conveyors transport coal in panels.

Mining the Coal

The four portals at Moss No. 3 are identified as A, B, C and D. The A and B openings are on opposite sides of Tiller Fork and the C and D portals are on opposite banks of Cane Creek. Each of the four openings has three producing sections mining coal two shifts per day. In the near future the company expects to have all sections producing three shifts.

Section equipment includes one Joy 15-BU loader, especially designed for the Moss No. 3 mine; two 15-SC shuttle cars that carry an average of 13 tons of coal; one 10-RU universal cutter with 11-ft bar, equipped with its own water sprays and Manson wet rockduster; one CD-41 self-propelled coal drill using Kennametal or Carboloy carbide bits; and one Acme specially designed roof-bolter with Cleveland-LeRoi S12 dust-collecting stopers.

Section crews include the following 12 men: 1 loader operator, 2 shuttle car operators; 2 cutters, 1 driller, 2 bolters, 2 shotfirers, 1 utility man and 1 foreman. Section crews have produced over 1,500 tons of raw coal per shift and the company expects to average 1,000 tons per crew per shift.

The universal machine cuts the coal horizontally below the band of impurities, splitting the coal, and also center shears it. Another job for the cutting crew is to drop back after completing the cut and shear any overhanging rib coal.

Because of the varying thickness of the total coal seam as well as the rock parting, the company varies drilling and blasting techniques to meet the changing conditions. The number of drillholes varies between 10 and 16 and their spacing depends on seam conditions. Holes are charged with American Cyanamid No. 11 permissible and tamped with Perma-Seal tamping plugs.

Underground workings are laid out in a 90-deg block system with square blocks on 80-ft centers. Main headings are driven 14 ft wide in groups of five or six. Panel entries are developed with eight headings. Each cut of coal yields 56 to 100 tons of coal. Full pillar extraction is planned.

The 15-BU loader, which was specially designed for the Tiller seam, has a loading capacity of 15 tpm. To limit the size of lumps that are fed to the belt conveyors Clinchfield equipped all loaders with lump breakers that limit the size of lump passing to the boom.

The two shuttle cars alternate carrying coal to a Columbus-McKinnon skid-mounted Ratio-Feeder that performs these three important jobs: (1) enables a shuttle car to discharge its 13-ton load in 45 sec; (2) distributes the coal evenly onto the belt; and (3) protects the belt by eliminating conveyor misalignments caused by shuttle cars bumping the belt. Damage from abrasion by spilled coal also is eliminated. The feeder is driven by a 30-hp DC motor and is in sequence with the panel belt. When a shuttle-car operator arrives at the feeder he pushes a button. The feeder runs for 3 min and then cuts off automatically. The rate of feed to the belt and the feeder's running time are adjustable.

The Ratio-Feeder is a chain and flight conveyor employing two converging chains as shown in the accompanying drawing. The flights from a wide high-capacity conveyor at the intake converge to a narrower lower-capacity conveyor at the discharge. The sloped-wall hopper provides temporary storage for the full shuttle car load. At the discharge end the side walls are formed to act as a choke to meter the coal uniformly onto the belt. The Ratio-Feeder is easily handled. It can be readily moved by a shuttle car or loader. Shuttle cars discharge into the feeder without running up onto a loading ramp.

After a cut of coal is loaded out the bolting crew moves in to install expansion-type ⅝-in high-tensile bolts with Bethlehem or Ohio Brass expansion shells on 4-ft centers in rows spaced a maximum of 5 ft apart. Additional bolts are installed if conditions demand it and three extra bolts always are installed along the rib at all intersections. All bolts are 42 in long but may be up to 72 in long in weaker roof.

As soon as the bolting machine is in position at the face, the operator extends four hydraulic jacks which level the machine and hold it firmly in position while bolts are installed. The machine's adjustable platform not only enables the two men to work at a comfortable height but also provides a base for the stopers, which are mounted on roller tracks for easy positioning. Air is piped to the face of each working place in 2-in aluminum pipe joined with Victaulic couplings and then carried to the drills by a short length of hose.

EXPEDITER speeds parts or supplies to four openings, keeps record of delays and notes movement of supervisors while underground. Four clocks, interlocked with main belts, indicate belt outages.

PLANNING OPERATIONS in division superintendent's office at Moss No. 3 mine are R. T. Huffman (left), production manager; W. A. Stapleton, division superintendent; E. E. Stepp, production engineer; and J. K. Berry, assistant to vice president, operations.

In the belt headings, treated wood headers are installed with bolts along one rib to provide anchorage points for electrical control wires. The headers sometimes also are used to provide additional bearing surface where tender roof is encountered.

Compressed air for operating the stopers is provided by Chicago Pneumatic YCM two-stage two-cycle water-cooled compressors driven by 75-hp 440-V AC motors. The units deliver 400 cfm. At each panel belt there is a Westinghouse Inerteen-filled 225-kva transformer that provides 440-V power for the compressor and belt drives.

All-Belt Haulage

Each of the main headings in the four portals is equipped with identical 48-in Goodman Rope Belts powered by two 150-hp 440-V AC motors. Conveyor belting is neoprene 5-ply 42-oz 3/16-in-top and 1/16-in-bottom cover with breaker. As the conveyor is lengthened one end of the new section of belt is joined with a vulcanized splice and the other with a mechanical joint so that additional sections can be spliced in. When a belt reaches its full 3,000-ft length the last splice is vulcanized, thus forming one continuous loop from head to tail section. Eventually some of the mainline conveyors in tandem will extend 3½ mi underground.

In the A and B portals Joy 36-in Limberoller rope-frame units feed coal to the main 48-in belts. Three Jeffrey 36-in rope-frame units carry coal to each of the 48-in belts in the C and D openings. Mainline belts travel 600 fpm and panel conveyors run at 500 fpm.

To prevent damage to conveyors as well as to eliminate coal pileup, all belts are equipped with the latest control devices. For example, all belts start and stop in sequence, have slippage protection, and have solenoid brakes to prevent belt runaway on downgrade installations.

Each belt drive also has its own built-in ammeter that makes it possible to spot at a glance any buildup of load in the drive motor. Thus trouble can be detected before it causes a breakdown. Plug-up paddles installed at all feeders and transfer chutes provide added protection against coal pileup at these busy junctions. A series of side switches at the head and tail sections stop the belt if there is misalignment of rubber. Each storage bin on the surface has a paddle switch that stops all inby conveyors if the coal level reaches the full mark.

Each protective device is wired to its own red and green indicator lights to help maintenance men speed trouble-shooting in event of a shutdown of the conveyor system. A burning green light shows that everything is operating normally at the device; a burning red light indicates trouble and means that the protective device has stopped the belt. If a protective device stops a conveyor a supervisor or mechanic can spot the trouble quickly by looking for a burning red light. Management notes that indicator lights at these protective devices will become increasingly valuable as the belt systems expand.

Outside the A and B portals the main-entry rope-frame belts extend as Hewitt-Robins rigid-frame units in metal-sheathed galleries. Idler diameter increases to 6 in from 5, and spacing of troughing idlers becomes 4 ft instead of 5. The rigid portions of the A and B 48-in belts extend to a 900-ton storage bin. From the bottom of the bin a Stephens-Adams pan conveyor feeds coal to a 54-in Hewitt-Robins belt that carries it to the railroad-car loading point.

The main 48-in conveyor in the C opening discharges coal into a chute that transfers it to a Hewitt-Robins 48-in rigid-frame unit for delivery to a 900-ton storage bin. Coal then is fed to a 48-in belt and carried to the railroad-car loading point for the C and D portals.

At the D opening a short section of rigid-frame conveyor connects to the underground rope-frame unit and extends to a second 900-ton storage bin. A Stephens-Adams feeder delivers coal to another 48-in belt which also feeds coal to the car-loading point.

SUPERVISORS at Moss No. 3 include J. J. Johnson (left), chief electrician, A and B portals; Ballard Taylor, assistant superintendent, maintenance; Milton Bentley, superintendent, C and D portals; John Simpson, superintendent, A and B portals; Hubert Lawson, supply clerk; W. A. Stapleton, division superintendent; J. H. Cope, safety engineer; H. W. Bryson, (standing left), shop foreman; and Hobart Hall, chief electrician, C and D portals.

Coal from both the A-B and C-D loading points then moves to the Moss No. 3 preparation plant over 8 mi of the Norfolk & Western Ry. Train crews make four trips a day between the plant and loading points.

Preventive Maintenance

Clinchfield relies on a preventive-maintenance program to keep equipment delays to a minimum during the production shifts. On the third shift a foreman and eight maintenance men work full time on preventive maintenance at each pair of portals. These men rotate from section to section, spending an entire shift on each.

If there is a breakdown during a production shift the section foreman calls the shop and a mechanic is sent underground. By the time the mechanic arrives at the section the machine operator usually has the machine partially ready for the mechanic to install a new part.

As more experience is gained with the new machines the company plans to establish a unit changeout system for key components. The goal of this program will be to replace a key component before it fails and causes a delay in production.

Expediter is Nerve Center

To keep track of underground activities, speed delivery of parts and supplies to the face and in general provide a nerve center for mine operation, Moss No. 3 employs an expediter on each producing shift. He is constantly in touch with every section, knows the section conditions at any given time, and records the movement of the superintendents, assistant superintendents and mine foremen as they go from one section to another, thus making it possible to contact any of them immediately.

At the beginning of each shift each section foreman checks his section and evaluates his conditions. He then goes to a Femco battery-powered transistorized telephone at the loading point and calls in to the expediter his estimate of the number of shuttle cars to be loaded that shift. As soon as the first shuttle car of coal is dumped either the car operator or the section foreman calls the expediter. Top management notes that this early reporting not only encourages the crews to get production rolling early but also fosters competition among the crews.

At a prearranged time near the middle of each shift all section foremen pick up the mine telephone and join the mine foreman in a short telephone conference. Each foreman first reports to the expediter the work done up to that time, what is ahead of him in the way of prepared coal and his mining conditions.

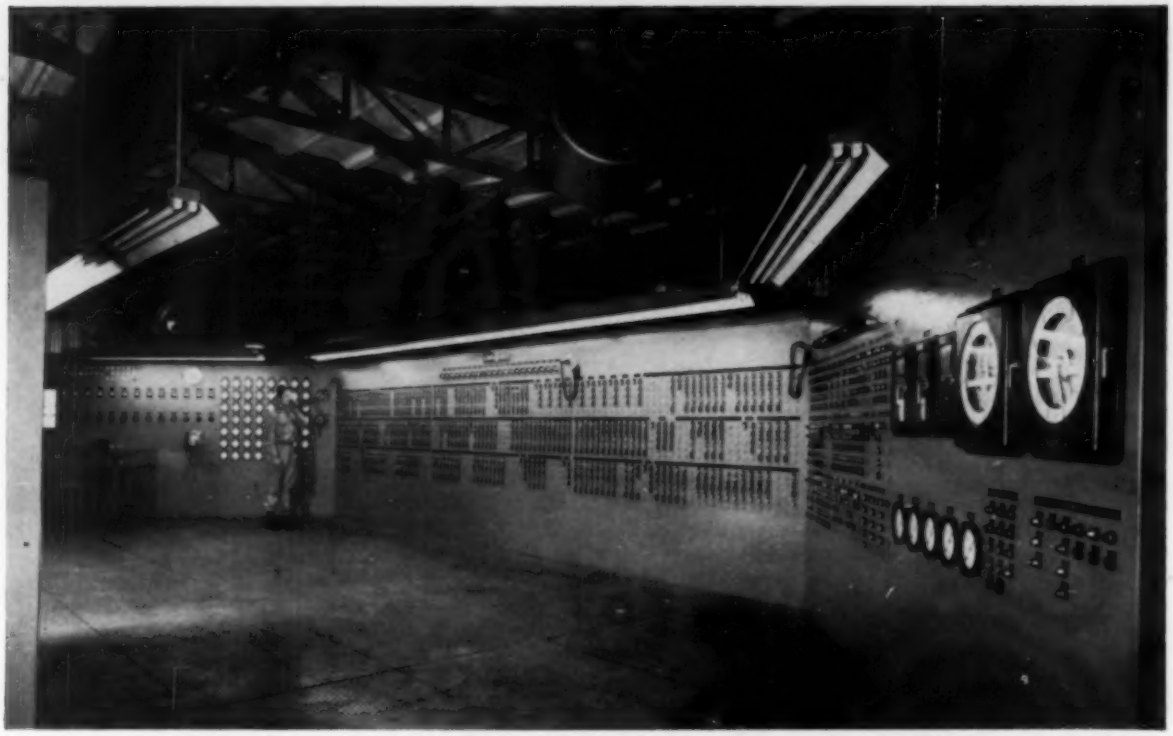
Mine management reports that these conferences are extremely valuable as a builder of a cooperative spirit among the section foremen. For example, if one foreman reports a new problem during one of these conferences he can immediately benefit from the experience of another foreman who previously had a similar problem. Another advantage of the phone conference is that a foreman needing a certain tool or supplies frequently can get the materials from a neighboring section.

The expediter also keeps a delay record for each piece of equipment and makes a daily delay summary. He also keeps a monthly delay summary up to date. Four electric clocks, each interlocked with a drive on one of the 48-in main belts, hang on the wall of his office and enable him to record the running time of each main belt each shift.

Ventilating the Mines

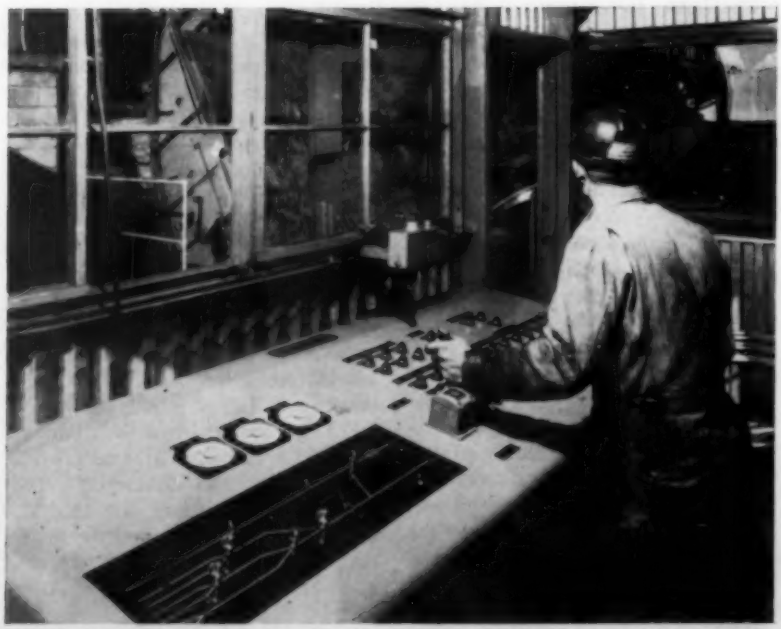
Fresh air for both the A and B openings is provided by Jeffrey 8H 7-ft Aerodyne fans delivering 232,000 cfm at ¾-in w. g. A 50-hp 440-V, 1,175-rpm motor drives each fan.

Two 7-ft Aerodyne Jr. fans provide air for the C and D workings. The unit at the C opening delivers 135,000 cfm at ¾-in w. g. and the fan at the D portal delivers 122,700 cfm at ¼-in w. g. When mine workings become more extensive later this year these fans will be replaced with Jeffrey 8H Aerodyne units.



90% OF MACHINERY in plant is controlled by single operator. This 80-ft panel contains all pushbuttons, selector switches, indicating lights, ammeters, audible signal devices and other instruments for washing portion of plant.

Automation Keys Two-Stage



DUMP OPERATOR sets controls for dumping cars and operates switches to direct cars to desired track. Track layout on panelboard has lights to show full tracks.

One man has at his finger tips control of 90% of 1,500-tph plant featuring four independent coarse- and fine-coal washing circuits. Nucleonic density controls on heavy-media washers assure consistently high quality of coal.

CLINCHFIELD'S MOSS No. 3 aluminum-clad preparation plant, with a 1,500-tph capacity, was designed, built and erected on a turnkey contract by the Link-Belt Co. The coarse coal is cleaned in Link-Belt's new tank-type heavy-media vessels and the fine coal on Diester Concentrator twin-deck tables in four parallel coarse-coal and fine-coal circuits.

GIGANTIC Moss No. 3 preparation plant stands 10 stories high and has four independent washing circuits with heavy-media, wet tables and flotation cleaning units. Coal comes from mine over tracks at right and is unloaded by rotary dump.

Precision Washing at Moss No. 3

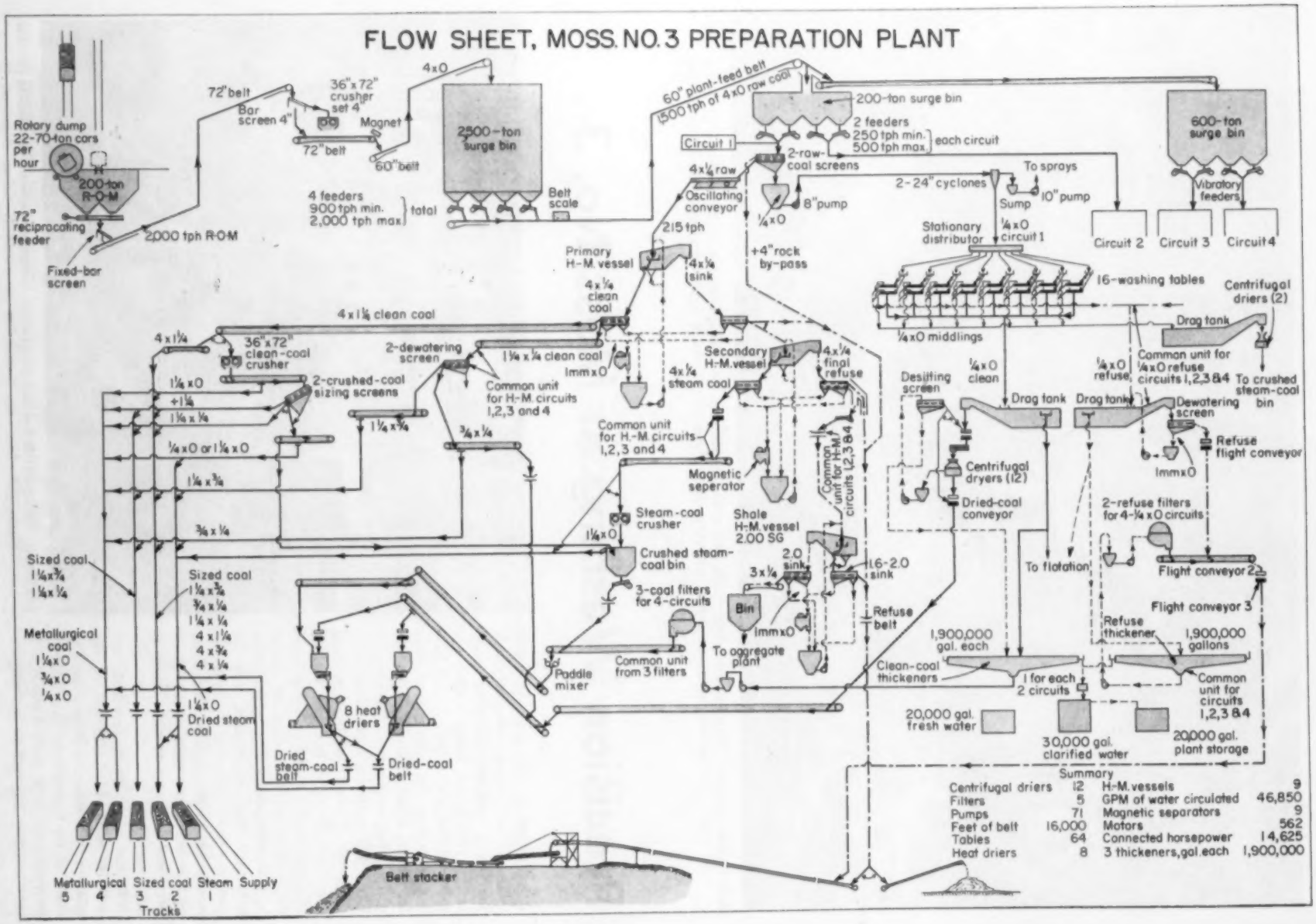
After cleaning, the coal undergoes additional processing, including crushing, sizing, mechanical dewatering and heat drying before being loaded into railroad cars.

One man in the main control room has at his finger tips control of 90% of the plant's operation. Operators at four other control stations handle the dumping of raw coal from railroad cars, heat drying of fine coal, loading of clean coal into railroad cars, and dumping of refuse in a valley almost half a mile away. The plant is so automatic that it requires only 18 men per shift, including greasers and mechanics. Strategically-located Femco communication units enable plant personnel to contact each other at any time.

In the near future profitable use will be made of 1,000 tpd of the plant refuse, which will provide raw material for lightweight aggregate to be produced in a plant Link-Belt is now building adjacent to the prepara-

LOADING OPERATOR has full pushbutton control of railroad car loading on four tracks. All clean coal is sampled automatically before shipment.

FLOW SHEET, MOSS NO. 3 PREPARATION PLANT



RAW COAL feeds from rotary dump to crusher station at rate of 2,000 tph, then passes to 2,500-ton storage bin.

CRUSHED RAW COAL flows to 200-ton surge bin at top of plant or to a transfer belt leading to a 600-ton surge bin.

FINE COAL is separated into three products by 32 tables, eight for each circuit. Products discharge to drag tanks.

FLOTATION CELLS, recent addition to the plant, upgrade extreme fines to metallurgical-quality product.

tion plant. The lightweight aggregate will be marketed under the name of Clinchlite.

Water circulates through the plant at the rate of 46,850 gpm. A water-clarification system recovers extreme fines from the water, which is reused in a closed system, thus conserving the plant's water supply and avoiding pollution of streams.

The main building of the preparation plant is almost the size of a football field, 287 ft long and 156 ft wide. The roof of the tallest structure is 113 ft above ground level, or about 10 stories high. About 900 ft to the north is the rotary railroad-car dump, with delivery tracks for 302 railroad cars. Belt conveyors connect the dump house with a crusher house and storage bin. A long gallery runs from the base of the bin to the top of the plant. To the west is the loading area, with eight tracks, five for loading. The loading tracks have capacity for 222 cars.

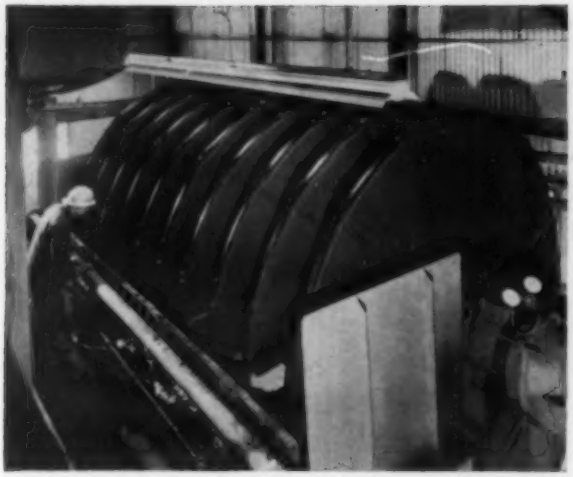
Moss No. 3 Preparation Supervisors

B. F. Hendrickson, plant superintendent
Fred Collins, first-shift foreman
William Lyles, second-shift foreman
Luther Nichols, maintenance foreman
Andrew Hall, second-shift maintenance foreman

Major equipment includes nine tank-type heavy-media washers, 36 vibrating screens, three crushers, 64 Deister Concentrator twin-deck concentrating tables, five drag tanks, 12 Reineveld centrifugal driers, eight Multi-Louvre heat driers, three thickeners, five Eimco vacuum filters, 10 Wemco flotation cells, and 16 Microdyne dust collectors.

There are 14 vibratory feeders, 20 screw feeders, a reciprocating feeder, four oscillating conveyors, 30 flight conveyors, 32 screw conveyors, 51 pumps and 22 belt conveyors. Total length of the belt conveyors is about 8,000 ft, with widths ranging from 24 to 72 in. Raybestos-Manhattan belting is used on all belt conveyors.

The plant has a total connected motor load of 13,650 hp. It uses 562 motors, from fractional to 400 hp, of which 23 are 200 hp or more. About 240 mi of wire and more than



VACUUM FILTERS reduce moisture of extreme fines to 24%. Filter cake is mixed with larger sizes and sent to heat driers.

TURNOVER feature of refuse belt keeps carrying side up on return run and then turns it over again at tail section.

NUCLEONIC density-measurement system for heavy-media washers continuously shows gravity of each vessel on panelboard. Magnetite is added by pushbutton.

PLANT SUPERINTENDENT B. F. Hendrickson (right), at panelboard.

12 mi of conduit were used. The plant has some 600 pushbuttons. All motors and controls are General Electric.

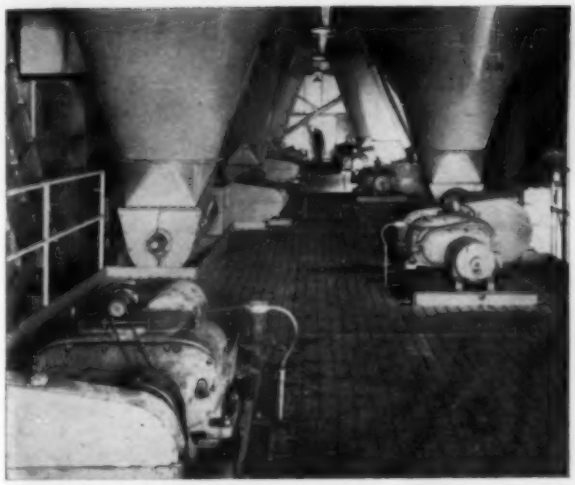
Railroad crews place 70-ton loaded cars on the loaded tracks where Clinchfield's switching crew takes over and uses a General Motors 110-ton diesel-electric switching engine to handle cars, 16 in a string, between the sidetracks and dump. To eliminate the possibility of a car runaway on the 2½% grade to the dump a remotely controlled runaway switch is always kept open. Controlled from the dump operator's station, the switch is closed only when the switch engine is passing through.

From a 200-ton hopper under the rotary dump the raw coal is carried to the crusher station by a 72-in belt at the rate of 2,000 tph. Here it is reduced to 4x0 by a McLanahan & Stone 36x72 double-roll crusher, and tramp iron is removed by a Stearns self-cleaning magnet. To protect the belt from damage by larger pieces of iron that the self-cleaning magnet may not be able to reject, a special control device is included in the belt controls to stop it when a large piece of iron is encountered. The crushed coal is delivered by belt conveyor to a 2,500-ton storage bin.

Every unit back from the 2,500-ton bin to the dump operator's station is controlled by the dump operator. He also sets switches by pushbutton to direct cars to the desired track for loading of prepared coal. His controls are so designed that the rotary dump cannot be operated unless there is at least one clear track. Indicator lights on a schematic track diagram show red if a track is full.

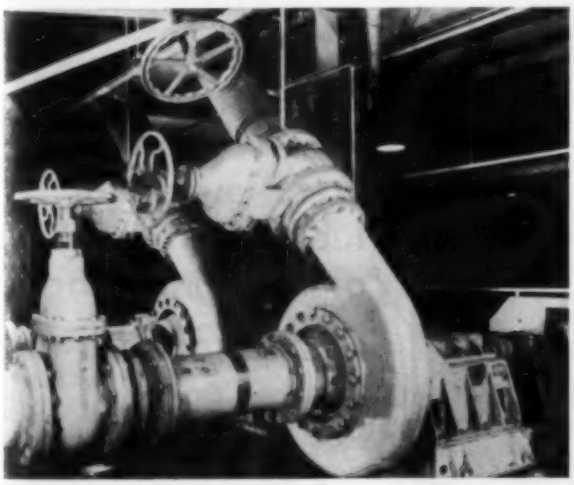
The coal is carried to the top of the preparation plant at the rate of 1,500 tph by a 60-in inclined belt, being weighed electronically enroute by a Merrick Weightometer. It is either deposited in a 200-ton surge bin or transferred to another belt to a 600-ton surge bin.

Coal is reclaimed from the surge bin by four pairs of Syntron vibratory feeders discharging to four pairs of Lecco double-deck horizontal vibrating screens equipped with Hoyt woven-wire and Bixby-Zimmer stainless steel B-H Loop screens. These



EIGHT HEAT DRIERS are fed from their respective surge bins by variable-speed screw feeders controlled remotely.

TWELVE centrifugal driers, including two standbys, reduce surface moisture of fines from about 40% to 7%.



DUAL INSTALLATION of all plant pumps prevents costly downtime and simplifies maintenance or replacement.

TOWER BOOM at end of refuse belt spreads refuse in 180-deg arc. A traveling belt with stacker will be added.

screens scalp out slabby rock, remove the ¼x0 coal by wet screening, and prewet the 4x¼ coal. After this initial separation, coarse and fine portions of the feed flow through their respective washing circuits.

Coarse-Coal Washing

The 4x¼ coal from each pair of vibrator screens flows to a 48-in oscillating conveyor for delivery to one of four Link-Belt tank-type primary heavy-media vessels. The clean coal floats across the bath and discharges with its carrying medium over a weir onto a Lecco 6x16-ft vibrating screen equipped with Hoyt woven-wire screens for draining the free medium back into the system, rinsing the magnetite from the coal and sizing the coal into 4x1¼ and 1¼x¼ fractions. The heavy material sinks to the bottom and is removed by a double-strand flight conveyor. The 1¼x¼ is further dewatered and sized into 1¼x¾ and ¾x¼ products on Allis Chalmers Low Head vibrators equipped with Bixby Zimmer B-H Loop screens. Magnetite in screen underflow is recovered by a Jeffrey permanent-type separator. Recovered magnetite is recirculated to the heavy-media vessels by Goyne 8-in pumps.

Each primary vessel has an approximate specific gravity of 1.35, producing a float product of clean high-quality metallurgical coal and a sink product of refuse and steam coal.

The primary sink product is drained, rinsed and dewatered on Allis-Chalmers 6x6-ft Low Head vibrators and then fed to four secondary tank-type heavy-media vessels with approximate specific gravity of 1.50. The float is steam coal; the sink is refuse.

A ninth tank-type heavy-media unit will be employed in the future for separation of the shale refuse at 2.0 specific gravity. The sink product will be dewatered on a 6x16-ft Link-Belt horizontal vibrator and conveyed to a bin feeding the aggregate plant.

At the present time all the refuse from the secondary washing units is dewatered on an Allis-Chalmers 6x16-ft Low Head vibrator and fed to a 2,400-ft belt to a stacker unit.

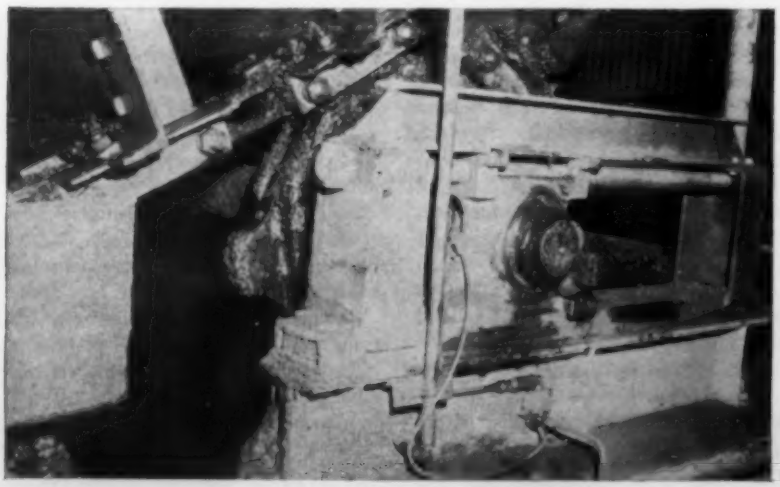
The various fractions of clean coal are screened and crushed as necessary

SLIDE-IN PLATES of abrasion-resistant alloy line flight conveyors. Plates are bolted in place for easy removal, thus minimizing replacement time.

THREE-PIECE conveyor flight can be repaired or replaced easily.

Long-lived materials and automatic lubrication reduce plant maintenance cost

CENTRALIZED lubrication system delivers measured quantities of the proper grease regularly from original drums to all plant units.



HEAVY-DUTY steel takeups on all plant flight conveyors make possible trouble-free operation. These takeups also have long life.

CAST-STEEL sprockets last longer and tapered track prevents flight damage.

RESEARCH and testing laboratory is equipped with the most modern facilities for making complete coal analysis and for making coking tests.

to provide the end products desired. Any fine coal in these circuits is delivered to the heat-drying section of the plant.

Nucleonic Gravity Measurement

To maintain close control over the specific gravity of the eight heavy-media washing units, Clinchfield employs AccuRay nuclear density-measuring systems. Each heavy-media vessel has its own AccuRay unit which not only continuously indicates on a panelboard the specific gravity of the magnetite and water mixture in the vessel but also records it on a chart. The measuring system consists of a measuring head, a preamplifier and an instrument. The instrument has a meter on its front panel to indicate the density, and a recorder.

Developed by Industrial Nucleonics Corp., Columbus, Ohio, the AccuRay system operates on the principle of radiation absorption. A source of gamma radiation is mounted on one side of a short section of pipe, called the pass tube. A radiation detector is mounted on the opposite side of the pass tube. Since radiation absorption is proportional to the mass it is passing through, if the density of the constant volume filling the pass tube changes the concentration of radiation entering the detector changes. The detector converts the concentration of radiation entering it into an electrical signal which is measured and read in terms of specific gravity of the medium.

The housings for the radioactive source and the detector are welded to the pipe section. These housings not only are designed to withstand abuse but also to lower the radiation to a level below the recognized tolerance.

The preamplifier is an electronic unit which receives the signal from the source detector unit and matches it to the input characteristics of the instrument. The instrument itself contains operating controls, setup controls, power supplies, regulators and the indicating meter for the AccuRay system.

There are two controls on the panel for adjusting the range to be measured, or for calibration. After the system is calibrated these controls are locked. Two other controls, Check 1 and Check 2, are provided and are adjusted periodically. Check 1 balances the electronic circuitry of the instrument. Check 2 compensates for the gradual decay of the radioisotope and erosion of the pass tube itself.

In operation, the instrument is calibrated so that at the operating gravity of a dense-media vessel the indicator reads at the center of the scale. Thus an increase or decrease in specific gravity causes the needle to move left or right and enables the plant operator to spot at a glance if a correction should be made. If the operator sees the specific gravity fall, he pushes a button that feeds magnetite to the vessel from an in-plant 100-ton bin.

Clinchfield engineers say that density controls make it possible to maintain the specific gravity in the eight dense-media vessels with a degree of precision that would be impossible with hand methods. As a result the quality of the washed coal is kept consistently high. Furthermore, with hand methods it would be necessary to employ one or more men full time to test the specific gravity of the vessels and make adjustments. Even then washing results would not be nearly as uniform as with the nucleonic controls.

Plant Operating Crew

1 switcher engineer
1 switcher brakeman
1 dump operator
1 car operator
1 loading-point operator
1 loaded-car handler
1 drier-furnace operator
1 heavy-media pump operator
1 filter operator
1 table operator
1 main plant operator
1 refuse stacker operator
1 electrician
5 repairmen

Fine-Coal Washing

Fine coal that passes through the raw-coal vibrators in each of the four washing circuits flows to individual sumps. A Morris 8-in pump picks up coal from each sump and delivers it to two Heyl & Patterson 24-in low-pressure cyclones which remove part of the water. Underflow from each pair of cyclones feeds a stationary distributor that splits and delivers the coal to eight Deister Concentrator twin-deck wet washing tables. Cyclone overflow is recirculated by a Morris 10-in pump and used as spray water on the raw-coal screens. The tables make a three-product separation into clean coal, middlings and refuse.

The clean coal from the tables in each circuit enters a drag tank. The ¼x100M coal settles in the tanks and is conveyed to 12 Reineveld centrifugal driers which serve all four fine-coal circuits. The centrifugally dried coal is then conveyed to the heat-drying section of the plant.

Minus 100-mesh material overflows from the drag tanks to one of two 130-ft-diameter clean-coal thickeners which recover the fine solids and

Underground CP drilling *is right*

CP ROOF BOLTING UNIT RBD-30S-579 provides *new speed, new safety*. Takes less than 3 minutes to complete the whole bolting cycle – drilling to bolt setting. *New*, separate tramming motor, with dual wheel drive, permits fast, easy movement from place to place. Instant forward, stop and reverse push-button controls speed up positioning of unit when drilling holes.

Every hole this rig drills is just right . . . no doglegs! Perfect holes means safe bolt installation. Furnished with low speed spindle adapter and low seam drilling attachment.

CP-35-HCD HYDRAULIC COAL DRILL is completely safe . . . no sparks or shocks possible. Hydraulic motor cushions against stalling in bad seams. Easy to handle, weighs only 35 pounds, vibration held to a minimum since auger speeds are less than 1000 rpm. Long augers easy to handle. Operates off power system of cutting, timbering, and roof bolting machines.

CP-3630-RPSH IMPACT WRENCH provides the utmost in speed, power and economy. Ideal for tightening and reclaiming roof bolts – has the power and compactness for overhead work. Other models in capacities from ½" to 1¾" bolt size are available to handle hundreds of maintenance jobs, quick and easy.

NEW CP AIRLEG COMBINATION utilizes the hard hitting CP-69 Sinker Drill. Airlegs either 36" or 48" standard or 72" telescopic for special requirements. Pressure-balanced ratchet-type throttle insures full bit contact needed to eliminate slapping and bit breakage. Emergency pushbutton release instantly releases feed leg pressure. New type beaver tail retainer eliminates retainer springs . . . improves steel retention and reduces steel breakage. Has universal backhead for blower-dry, wet and automatic air-water operations.

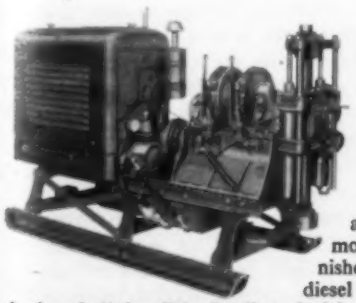
or open-pit equipment *on the job*

Hard coal or soft, underground or open pit, CP drilling equipment is *right on the job.*

There is equipment for any formation that will handle your toughest job with ease . . . keep production figures high, costs low. Typical equipment includes:

- **Exploratory Drills**
- **Blast and Shot Hole Drills**
- **Roof Bolting Equipment**
- **Airlegs**
- **Three-cone Air-Blast Bits**
- **Stationary and Portable Air Compressors**

For full details write: *Chicago Pneumatic Tool Company, 8 East 44th Street, New York 17, N. Y.*



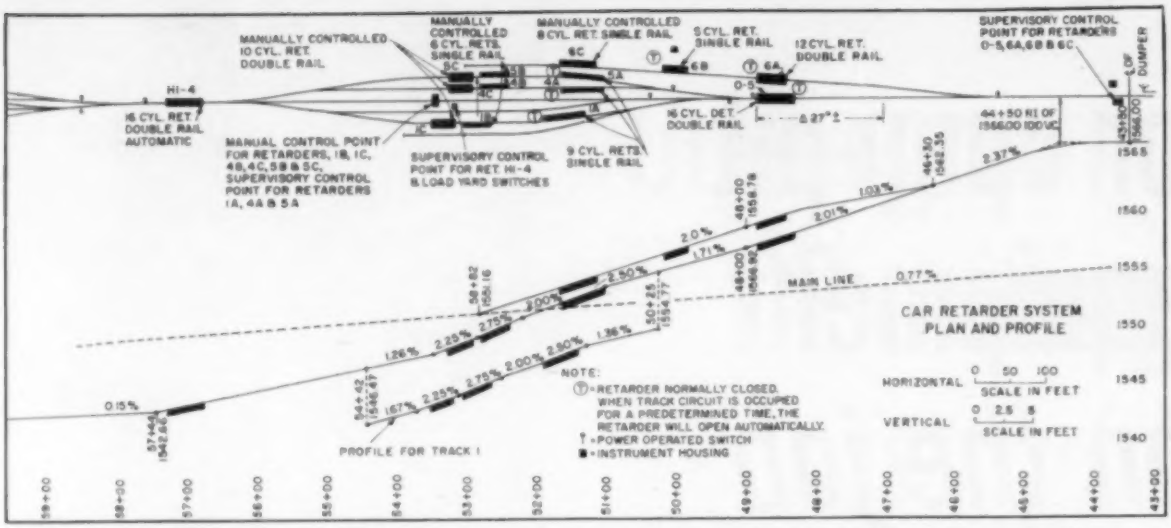
CP-15HD DIAMOND DRILL is designed for exploratory work. This skid-mounted unit can be furnished with gasoline, air or diesel drive and with screw feed or built-in oil hydraulic swivel head. The unit is exceptionally easy to handle and can be moved readily from hole to hole under its own power.

CP REICHDRILL, the newest member of the CP drilling equipment line is the product of the pioneer in portable hydraulic rotary drilling rigs. It is available either truck or crawler mounted. These hydraulically-powered rotary drills are cutting drilling costs in all types of mining operations because of top hydraulic drive, infinitely variable drilling speed, easy one-man operation, quick stem loading and dependable service.

CP 3-CONE AIR-BLAST BITS are built for rotary deep hole drilling. Jet nozzles provide high-velocity hole cleaning action. There's a bit designed for all formations ranging from very soft to extremely hard. Bit sizes range from 5⅜" to 12¼".

Chicago Pneumatic 8 East 44th St., New York 17, N.Y.

PNEUMATIC TOOLS • AIR COMPRESSORS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS • VACUUM PUMPS • AIR BLAST BITS


MANUALLY CONTROLLED 10 CYL. RET. DOUBLE RAIL
MANUALLY CONTROLLED 6 CYL. RETS. SINGLE RAIL
MANUALLY CONTROLLED 8 CYL. RET. SINGLE RAIL
5 CYL. RET. SINGLE RAIL
12 CYL. RET. DOUBLE RAIL
SUPERVISORY CONTROL POINT FOR RETARDERS 0-5, 6A, 6B & 6C
HI-4
16 CYL. RET. DOUBLE RAIL AUTOMATIC
MANUAL CONTROL POINT FOR RETARDERS, 1B, 1C, 4B, 4C, 5B & 5C. SUPERVISORY CONTROL POINT FOR RETARDERS 1A, 4A & 5A
SUPERVISORY CONTROL POINT FOR RET. HI-4 & LOAD YARD SWITCHES
9 CYL. RETS. SINGLE RAIL
16 CYL. RET. DOUBLE RAIL
MAIN LINE
CAR RETARDER SYSTEM PLAN AND PROFILE
PROFILE FOR TRACK 1
NOTE:
Ⓣ = RETARDER NORMALLY CLOSED. WHEN TRACK CIRCUIT IS OCCUPIED FOR A PREDETERMINED TIME, THE RETARDER WILL OPEN AUTOMATICALLY.
† = POWER OPERATED SWITCH
■ = INSTRUMENT HOUSING
HORIZONTAL SCALE IN FEET
VERTICAL SCALE IN FEET

AUTOMATIC RETARDERS control railroad cars as they move from rotary dump to loading tracks. Car in photo is at inspection stopping point uptrack from loading center. Diagram shows layout of retarder system.

clarify the water for reuse. The suspended coal settles out and is raked off the conical bottom and discharged to a Denver diaphragm pump for delivery to a sump. There a Wemco unit picks it up and delivers it to three Eimco coal filters. The filter cake is blended in a paddle mixer with crushed steam coal and delivered to the heat-drying section.

Table middlings are diverted to a settling tank, dried in two Reineveld centrifugal units and then conveyed to the crushed-steam-coal bin for delivery to the Link-Belt Multi-Louvre heat driers.

Refuse from the tables travels through a single drag tank. The ¼x 48M material settles and is discharged to an Allis-Chalmers 6x16-ft vibrator equipped with 1-mm screen. It then drops onto a flight conveyor which carries it to the refuse-disposal belt.

Minus 48-mesh refuse from the drag tank is flumed to another 130-ft-diameter thickener. Settled solids are handled similarly to the coal solids in a separate circuit and then are dewatered by two Eimco filters and sent to the refuse belt.

In the near future, Clinchfield expects to upgrade to metallurgical quality about 75% of the coal now going from the thickeners to the vacuum filters and thence to the steam coal bin. At the present time five Wemco Fagergren flotation cells are installed in the refuse circuit and plans are under way to install similar cells in the clean-coal circuit. When the flotation installation is completed the company expects to recover an additional 75 tph of metallurgical coal.

Heat Drying

Eight Link-Belt Multi-Louvre driers meet the exacting heat-drying requirements for the fine coal. Five of these units are normally used to dry ¾x¼ metallurgical coal from the heavy-media process, together with the centrifugally dried product from the fine-coal system. Surface moisture is reduced to between 2 and 3%.

The other three driers are used for the steam coal, reducing surface moisture to about 5%. The driers are fed from their surge bins by remotely controlled P.I.V. variable-speed drives.

Exhaust gases from each drier receive primary cleaning in dry dust collectors and final cleaning in two Joy Microdyne wet scrubbers, with dust reclaimed either to dried-coal conveyors or the furnace-fuel feeder.

Several refinements incorporated in the design and controls of the thickeners add to over-all plant efficiency. For example, there is an Esterline Angus load control for automatically raising or lowering the thickener rake as the concentration of solids increases or decreases. As the load on the rake changes with changes in solids concentration the meter hand makes contact and closes an electrical circuit. A motor starts and raises or lowers the rake arms.

The rake can be raised as much as 24 in above the normal operating position, which adds considerable storage capacity to the thickener. At the end of the shift the arms are raised the full 24 in so there will be no problem when the plant is started.

Continuous production hangs on this shaft cable

Falling in unbroken, near-record drops of one-**third of a mile** each, two Okolite 5kv, strip-insulated shaft cables carry every bit of power down two separate shafts to Intermountain Chemical Company's vast trona mine in Westvaco, Wyoming . . . to operate diggers, loaders, conveyors, hoists, lights and blowers. Production, profits—and **lives**—depend on the absolute reliability of these cables.

"The cables are continually drenched by condensing moisture," says Jack Wilson, Intermountain's Maintenance Supervisor. Great length of the suspension puts tremendous vertical pressure on the cable components. Considering their importance as well as the tremendous job of replacing them, Intermountain naturally wanted the most reliable, longest-lived cable they could get. Those were two good reasons for choosing an Okolite-insulated construction.

For **your** circuits that must not fail . . . be sure to call in Okonite. For information on choosing the right cables for your jobs . . . write for free Bulletin CJ-1117, The Okonite Company, Passaic, New Jersey.

NEAR-RECORD CABLE DROPS

length: 1700 feet in each shaft

suspension: from a single clamp at shaft collar

construction: 3/c, 5kv, Okolite-insulated by strip process, with galvanized steel armor overall

weight: 19,000 lbs. each

tested: by 40,000 volts DC each

circuit and load: 4,160 volts from termination of Okolite-Okoprene aerial cables to power centers in mine

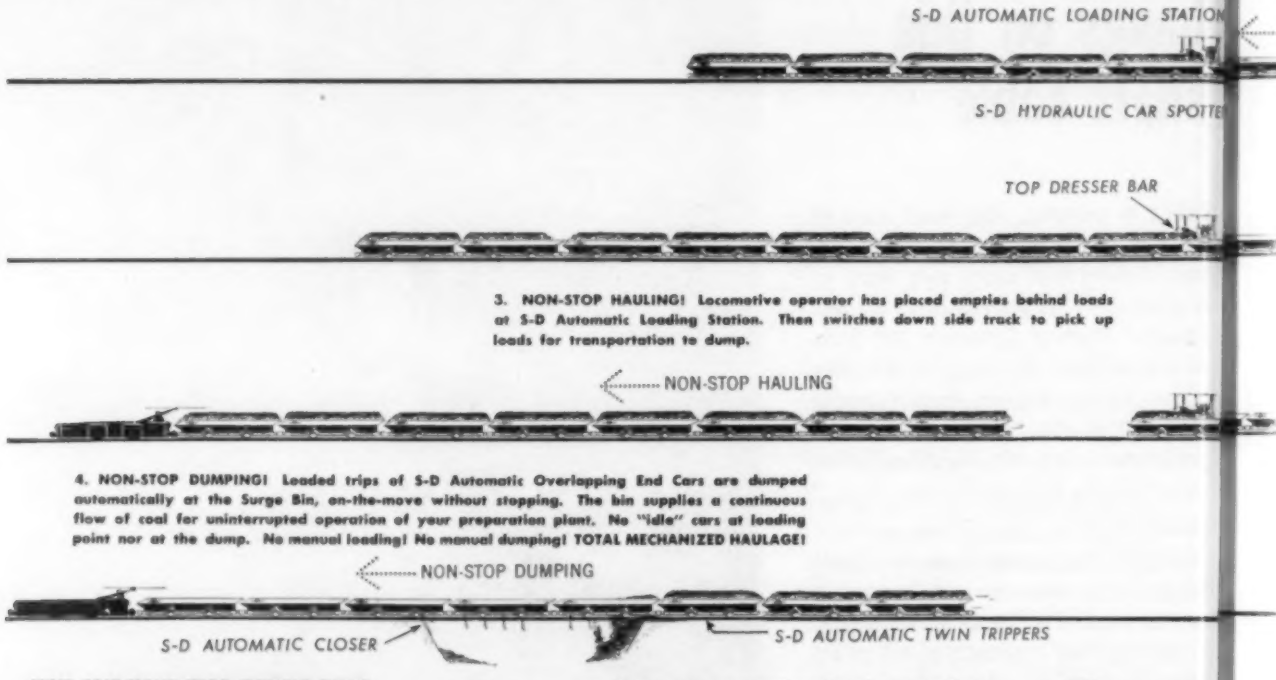
where there's electrical power . . . there's **OKONITE CABLE**

6217

Our mine car engineers are sure working for you . . .

Now you can eliminate

But that's just the beginning of the enormous savings!


S-D AUTOMATIC LOADING STATION
S-D HYDRAULIC CAR SPOTTER
TOP DRESSER BAR
3. NON-STOP HAULING! Locomotive operator has placed empties behind loads at S-D Automatic Loading Station. Then switches down side track to pick up loads for transportation to dump.
NON-STOP HAULING
4. NON-STOP DUMPING! Loaded trips of S-D Automatic Overlapping End Cars are dumped automatically at the Surge Bin, on-the-move without stopping. The bin supplies a continuous flow of coal for uninterrupted operation of your preparation plant. No "idle" cars at loading point nor at the dump. No manual loading! No manual dumping! TOTAL MECHANIZED HAULAGE!
NON-STOP DUMPING
S-D AUTOMATIC CLOSER
S-D AUTOMATIC TWIN TRIPPERS

YOU CAN NOW STOP BUYING MINE CARS . . . and START BUYING A HAULAGE SYSTEM that:

(1) provides a constant carrier for your continuous mining efforts to haul the coal away just as fast as it is mined . . .

(2) keeps a constant supply of coal available in Surge Bin for continuous and uninterrupted operation of your preparation plant . . .

(3) operates with minimum labor and minimum maintenance.

(4) requires low initial capital investment and operates at low cost per ton of production.

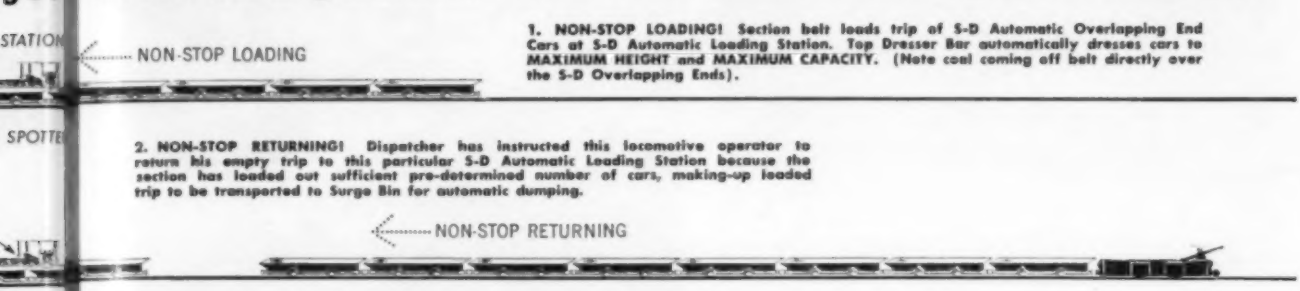
As you have already noted in illustration above, it makes no difference whether an S-D Automatic Overlapping End Car is in trip enroute to or from the dump . . . or in a trip being loaded . . . or in trip rolling across the dump to be emptied (and it has to be at one of those places AT ALL TIMES) — the car and the trip it is in are constantly and continuously AT WORK!

Here is what happened in actual loading of mine cars before our engineers developed the S-D Overlapping End Car, which provided practical and effective application of Automatic Loading Stations. Conventional cars were loaded in series of uneven "heaps" or surcharges, some of which were higher than roofing limitations — causing spillage and further, not providing level-width across top of surcharges to natural angle of repose for maximum loads, and also resulting in a hill-and-valley partial load.

NOW, since the development of the S-D Automatic Overlapping End Car, mine operators are installing a simple cross-bar or U-shaped-bar equal in height above rail to their minimum haulageway roof clearance. This is installed just beyond belt-head. The limit switch controls at the automatic loading station are set to permit each car to be loaded higher than haulageway clearance. Then, the Top Dresser Bar, as it is called, scrapes off the surplus, spreading the material sideward and also leveling the "humps" as loaded car moves under it. When end of car (and there may be some question whether S-D Overlapping End Cars have ends) is moved under this Dresser Bar, the surplus coal is plowed over the S-D Overlapping Ends into next car coming under belt to be loaded. Consider this for a moment. The only practical method to obtain a MAXIMUM LOAD is to load the car high and scrape surplus from one car to another — and this is done automatically! Movement of car-trips at these Automatic Loading Stations is accomplished by Sanford-Day Hydraulic Car Spotters or Sanford-Day "Brownie" Hoists. On a 10-ton S-D Overlapping End Car, for example, users report that Top Dressing permits them to load another ½ to 1 ton. This PLUS an additional ½ to 1 ton

every 6th car in a trip!

Gather round, gentlemen! Here is also NON-STOP MAXIMUM HAULAGE!


NON-STOP LOADING
1. NON-STOP LOADING! Section belt loads trip of S-D Automatic Overlapping End Cars at S-D Automatic Loading Station. Top Dresser Bar automatically dresses cars to MAXIMUM HEIGHT and MAXIMUM CAPACITY. (Note coal coming off belt directly over the S-D Overlapping Ends).
2. NON-STOP RETURNING! Dispatcher has instructed this locomotive operator to return his empty trip to this particular S-D Automatic Loading Station because the section has loaded out sufficient pre-determined number of cars, making-up loaded trip to be transported to Surge Bin for automatic dumping.
NON-STOP RETURNING

more payload obtained by the S-D Overlapping Ends themselves! SAVINGS? At one mine 250 S-D Automatic Overlapping End Cars are doing the work that previously required 293 of the same cars without Overlapping Ends. They eliminated every 6th car in a trip! How much tonnage are those 250 cars hauling? Four thousand tons per shift — 12,000 tons a day! (Maximum haul one way is six miles, minimum is three.) What happened to the tonnage carried by the other 43 cars? The S-D Overlapping Ends and their ability to assure MAXIMUM LOADING are now handling their loads! How much did the changeover save them? Approximately $250,000.00 annually! Due, in the main, to S-D Overlapping End Cars eliminating manpower at the loading stations.

Reason this direct comparison can be made is because this customer converted their conventional S-D Automatics by having us produce S-D Overlapping End "sections," which were installed on their cars at the mine. Only bottom dumping mine cars can have Overlapping Ends. You, too, can convert your present bottom dumping cars, height of car and curve radii permitting. If you are not using bottom dumping mine cars, you have the greatest opportunity in the history of mining to drastically reduce your haulage costs, an opportunity that deserves your immediate and serious consideration.

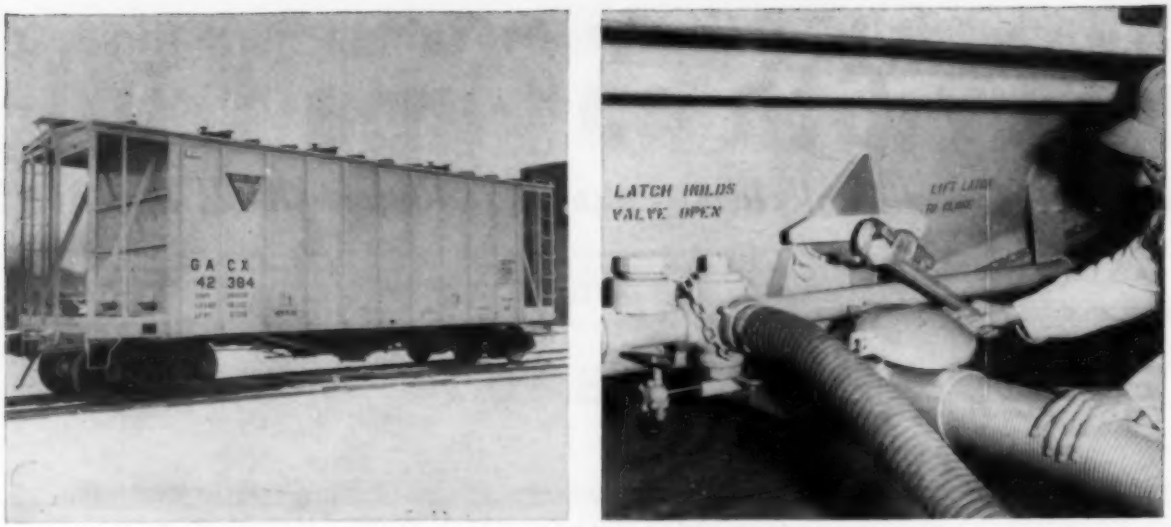
This Sanford-Day NON-STOP MAXIMUM HAULAGE system is in operation daily at several mines — some large, some small. To see any one of them will surely convince you. Would you like to know where they are? If not convenient to actually see one right away, call us and we will show you documentary filmed report or we will mail film to you so you can see and study at your convenience this NON-STOP MAXIMUM HAULAGE system in actual mine operations. You don't want to order another mine car, regardless of design, until you do. Write or call us today!

Sanford-Day Iron Works, Inc., Knoxville, Tennessee. Telephone 3-4191.

SANFORD-DAY

KNOXVILLE, TENNESSEE

MINE CARS — all types . . . S-D Brakeman Cars . . . S-D Man Cars . . . S-D Hydraulic Car Spotters and "Brownie" Hoists . . . S-D Automatic Loading Stations for mine and railroad cars . . . S-D "Floater" Wheels . . . S-D Mine Sheaves and Rollers . . . S-D exclusive Hard-Facing Process that puts old wheels back in operation for years of additional service.



EFFICIENT and economical bulk transportation and unloading of magnetite is provided by special self-unloading sealed cars. Compressed air (right) aerates magnetite, causing fluid-like flow through hose to in-plant bin.

The thickener also has two extra stub scraper arms at right angles to the large arms. These short arms were installed to prevent sudden changes in solids concentration in the feed to the filters, which occurred when only the long arms were on the rake. Solids concentration now is uniform and, as a result, filter operation is simplified.

Refuse Disposal

Plant refuse is collected on a 36-in belt conveyor which carries it 2,400 ft to the top of nearby hill where it is discharged to a stacker. The belt is driven by a 400-hp motor transmitting power through a Link-Belt D-250 speed reducer.

After discharging the material, the belt is turned over so that on the return run the top side of the belt is up. This prevents buildup of fine material on the return idlers. Near the tail section the belt is turned again to its normal position.

The refuse-disposal system has built-in flexibility so it can be adjusted as the pile grows. The tower boom stacker can be rotated in a wide arc and raised or lowered to discharge the refuse in the desired direction. At present this stacker is discharging directly into the valley. In the near future a rail-mounted 36-in trailing belt conveyor designed for sectional extension to a maximum length of 600 ft will be installed. This conveyor will discharge to a traveling fixed-boom stacker which will have a 70-ft radius of swing and a traversing speed of 6 fpm.

Automatic Sampling

Separate fully automatic sampling equipment is provided for both the dried steam and dried metallurgical coal ahead of the loading facilities. Each system includes a primary cutter, vibrating feeder, sample crusher and a secondary feeder with cutter.

A common sampling system is provided for the dewatered stoker coal and sized products. It includes a primary sample cutter for each belt and a common primary sample bucket which transfers the sample to the sampling column.

With the aid of the automatic sampling equipment one man is able to handle the sampling job for the entire plant. If hand methods were employed three men would be needed.

Pushbutton Car Handling

Three men at strategically-located control stations control all railroad cars as they move from the raw-coal dump downtrack to the loading points and then to the proper loaded track. Cars pass through a combination of automatic and manually-controlled Union Switch & Signal electro-pneumatic car retarders as they travel from the dump to loaded tracks. No car droppers are employed at the 1,500-tph plant.

Each empty car runs 450 ft by gravity from the rotary dump to an automatic 16-cylinder double-rail retarder where it is inspected, cleaned if necessary and made leakproof. The retarder releases automatically, freeing the car to roll to another automatic retarder 150 ft above the loading point. At the loading point manually-controlled retarders are employed above and below the loading point to control car movement as coal is loaded.

After a loaded car leaves the loading point it runs downtrack to an automatic double-rail retarder and then passes through an electrically-operated switch to the proper storage track.

One man controls car loading and also operates the hydraulically-controlled mixing gates that eliminate the need for screen changes in the plant. These gates are located in the clean-coal circuit so that each size may be mixed with one or more sizes to get the desired product. The push-button-controlled gates also eliminate the plant shutdowns that normally would be required for screen changes.

Better Magnetite Handling

To provide efficient and economical bulk transportation and unloading of magnetite for the heavy-media vessels, Clinchfield has two General American Transportation Corp. specially designed Airslide cars. The airslide car is a self-unloading sealed steel unit with weatherproof loading hatches and discharge outlets.

The self-unloading feature works

like this. Airslide fabric lines the bottom of the car's hopper trenches and extends the full length of the center sill. At the plant unloading point inlet and outlet hoses are connected to the car. Then a blower sends air into the chambers, permeating the Airslide fabric and aerating the magnetite. The air flow causes fluid-like flow through plastic discharge hose to a 100-ton bin in the plant. No vibration is required during unloading. Compressed air for unloading the magnetite and other service is provided by a Chicago Pneumatic compressor.

Individual Meters Aid Plant Operation

Individual ammeters for motors driving preparation plant units are installed on the main operating panelboard. These meters make it possible for the plant operator to tell at a glance what the load is on any unit. Furthermore, any unexplained or unusual increase in current demand shows up immediately on the meter and serves as a warning that something is causing an added load. Maintenance men then can search for the cause of the extra load and remedy the trouble before it causes a breakdown. The company notes that motor failures are virtually eliminated by relying on the ammeters to indicate loads and warn of potential trouble.

Hour meters also are key units that provide management with useful information on equipment life. The experience now being accumulated for the various plant units will be helpful in taking the guesswork out of maintenance timing. As a consequence few breakdowns are expected to be caused by worn-out parts.

Special Materials Cut Maintenance

To keep plant maintenance at a minimum Clinchfield included a number of money-saving ideas in plant design. For instance, all flight conveyors are lined with T-1 steel bottoms which are bolted in place and can be replaced in a minimum of time.

Each conveyor flight is made up of three pieces bolted together: the main or carrying piece and two end pieces. The carrying piece is secured to each end piece with two bolts. If a flight should become bent during an operating shift, the carrying part can be removed or replaced in a much shorter time than a conventional one-piece flight.

Other features incorporated to improve conveyor performance or reduce maintenance cost include cast-steel sprockets on conveyor drives so that they can be hard-faced later; heavy-duty steel takeups on all conveyors; and a tapered beginning for the chain track at the tail section to prevent damage to flights. Special Raybestos-Manhattan rubber pipe is used for all solids circuits.

To further reduce maintenance problems as well as keep parts inventory to a minimum, all pumps, screens, drives, motors, conveyors, controls and starters are standardized as much as possible. Standby pumps are installed for all circuits. Positive automatic lubrication of all plant equipment with Texaco products is provided by a centralized Trabon system installed by Riggs Engineering Co.

Power Distribution

Power for Moss No. 2 and Moss No. 3 operations is metered at 66,000 V at a common station at Moss No. 2. The Moss No. 3 power system is made up of two circuits, one serving the preparation plant and the other the mines. Each of these circuits is protected by an Allis-Chalmers oil circuit breaker.

After passing through the protective devices power is carried by separate polelines to the Moss No. 3 plant and to the mine. A General Electric 12,500-kva transformer at the preparation plant reduces voltage to 6,900 for distribution to 11 General Electric load centers for plant operation. Nine of these centers are 1,500 kva, one is 1,000 kva and one is 750 kva.

Three Allis-Chalmers 2,500-kva single-phase transformers reduce the 66,000-V power to 6,900 V for mine distribution. The 6,900-V power then is split into two circuits, one for the A and B portals and one for the C and D portals. Power is carried to each portal by overhead line, with branch lines along the way for outside lighting.

Each portal has its own cutout switch and Westinghouse breaker with ground trip. Power is carried underground at 6,900 V by General Electric 3-conductor preassembled aerial cable with built-in messenger unit. The cable is suspended from roof-bolts in the supply heading and carries power to AC and DC underground substations.

Each section has a Westinghouse 225-kva skid-mounted power transformer that steps 6,900-V power down to 440 for operating panel belt drives and air compressors.

DC power is provided for face equipment by a combinatton of mercury-arc rectifiers and m-g sets. At the A portal a 300-kw m-g set installed outside provides power for outside haulage in the supply yard and for underground supply haulage. A 300-kw rectifier near the load center supplies DC for face equipment at the A portal.

At the B portal a 200-kw m-g set provides DC power for the First Left section while a 300-kw rectifier supplies the remainder of the mine.

One 300-kw rectifier at First Right serves the C portal and two underground 300-kw rectifiers furnish power to the D portal.

Power is carried to portable nipping stations in each section by 500,000-cir mil copper feeders. The return includes 500,000-cir mil feeder to the 60-lb supply track, which is bonded and crossbonded to provide a good return.

Moss No. 3 Management

W. A. Stapleton, division superintendent, heads operations at Moss No. 3. John Simpson is superintendent at A and B portals and Milton Bentley is superintendent of C and D portals.

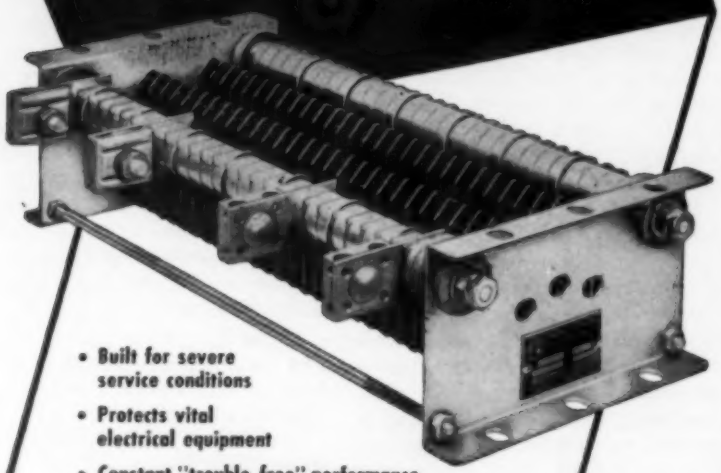
Other members of the operating staff include Warren Burkhead, asst. to div. supt., Foster Mullins, assistant superintendent, A and B portals; Douglas Harris, assistant superintendent, C and D portals; James Hutchinson, John Foy, Andy Branham and Jess Blanton, general mine foreman.

Moss No. 3 maintenance is under the supervision of Ballard Taylor, assistant superintendent, maintenance. Other maintenance supervisors include H. W. Bryson, shop foreman; J. J. Johnson, chief electrician, A and B portals; Hobart Hall, chief electrician, C and D portals; Charles Fox, Richard McNeil, Bathos Bentley and Henry Combs, assistant chief electricians.

Other key men at Moss No. 3 are

(Continued on p 96)

P-G Steel Grid Resistor
plays an essential part
in the production of COAL . . .

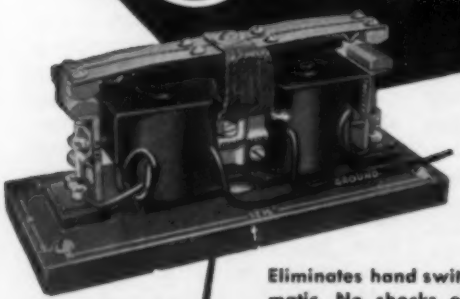


- Built for severe service conditions
- Protects vital electrical equipment
- Constant "trouble free" performance

These rugged nonbreakable units have proved their merit in all kinds of service for many years. Made of steel and mica, plus P-G unique and exclusive grid design, P-G Resistors are capable of protecting your most vital electrical equipment, even where service requirements are severe.

Designed to fit your present resistor space

P-G AUTOMATIC Transfer Switch



Single or double trolley and reel

Eliminates hand switches—entirely automatic. No shocks or burns to operator while changing from trolley to reel. Simple, safe, efficient, easy to install, can be mounted anywhere. For 250 to 600-volt service. Complete with cover.

P-G

THE POST-GLOVER ELECTRIC COMPANY
OFFICE and FACTORY—Kenton Lands Road, Erlanger, Kentucky
MAILING ADDRESS—Box 709, Covington, Kentucky

Howard Hill, mining engineer, J. H. Cope, safety engineer; Hubert Lawson supply clerk; E. W. Gillenwater, payroll clerk; Clarence Adkins, personnel clerk; Harry Elswick and Brady Sutherland, expediters.

Research and Testing

A complete coal research and testing laboratory, recently completed at a cost of $500,000 near the Moss No. 3 preparation plant is equipped with the most modern facilities for making complete coal analyses and for making coking tests. Facilities are housed in a 50x50x180-ft air-conditioned building with a 74x50-ft second floor. Research and testing are under the direction of L. J. Verno, manager of coke and coal evaluation.

The laboratory not only processes samples from all of Clinchfield's Virginia and West Virginia mines but also other coals sold by the Pittston Clinchfield Coal Sales Corp. Many foreign coals also are tested for customers.

Samples of coking coals are delivered to the laboratory in 500-lb to 15-ton samples, either in bags or 55-gal drums. Containers are dumped into a hopper feeding a belt conveyor. Coal then is crushed to ½-in top size, with 80% passing through a ⅛-in-square opening. The crushed product then is mixed in a large 1-ton Y blender that is turned for 300 revolutions at 14 rpm.

Blended coal is stored in sealed drums until tested. Mixes are prepared from the samples and tests run as requested by the sales division or by customers.

Clinchfield will be working with the ASTM and International Standards Organization to correlate test results and establish world-wide standards. The laboratory is equipped with the following for making coking tests:

1. A U.S. Steel 30-lb pressure oven.
2. A U.S. Steel adjustable-width coke oven.
3. An automatic Giesler for measuring coal fluidity.
4. A Mucahy sole-heat oven for measuring expansion and contraction.
5. An Arnu-Dialatometer.
6. An ASTM tumbler.
7. A modified European Micum tester.
8. A Henrich Koppers expansion-contraction tester.

Bring your trackwork problems to Bethlehem

▲ *SPECIAL TRACKWORK* like this can be designed, built and completely preassembled at our plant to be sure of perfect fitting at your site. The "Bethlehem approach" to your layout problem costs no more initially, and pays for itself in the long run.

A smooth, well-built haulage system is the backbone of efficient mining. That's why we urge you to bring your trackwork problems to Bethlehem. We have had long experience in the manufacture of rails and accessories, and this is backed up by operating know-how acquired in our own mines. We have the facilities and engineering to help you improve your transportation efficiency.

A Bethlehem engineer is ready right now to pay you a visit and talk over your needs with you. Why not call our nearest district office and arrange a get-together?

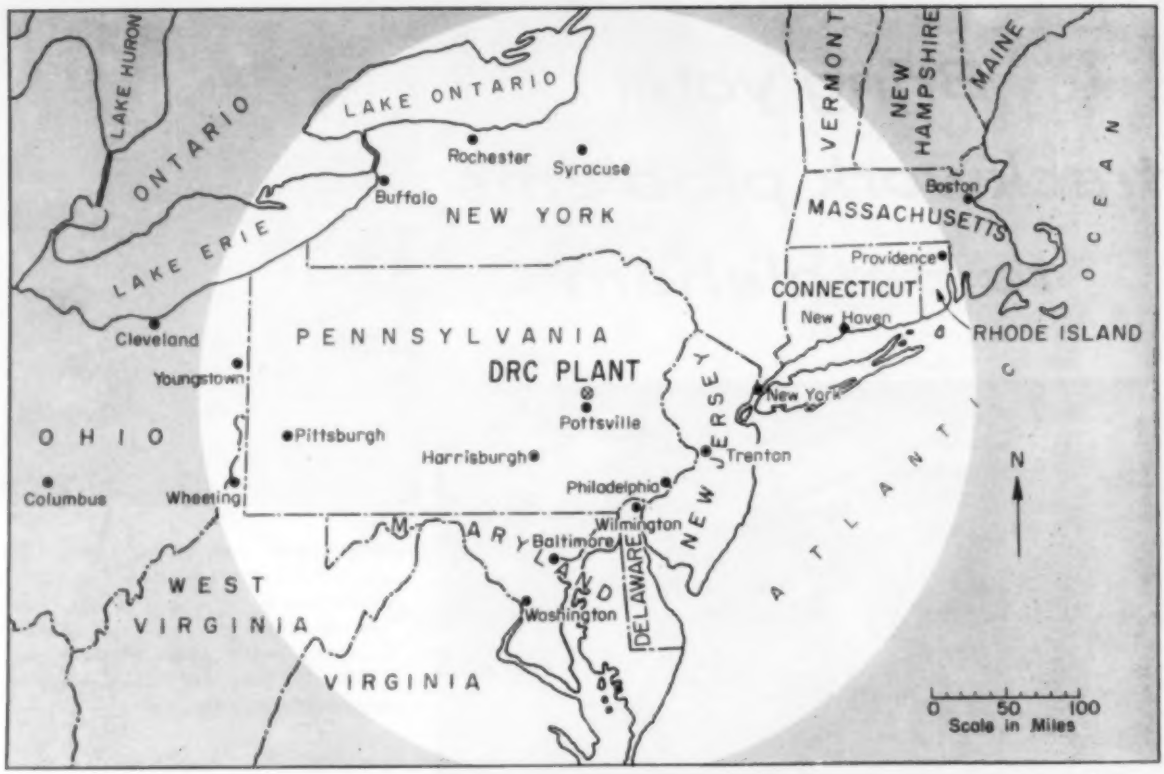
▲ *SWITCH STANDS,* such as the Model 1222, are a Bethlehem specialty. The 1222 is shown here in use with 85-lb rail. Notice how low and compact it is—over-all height is only 4¼ inches! The only moving parts are lever, crank, and sliding block—no maintenance worries there!

▲ *SWITCH HEEL BLOCK* Design 992 was developed by Bethlehem especially for use with mine turnouts. It helps maintain heel spread and track gage at heel end of switch, keeps closure rail and switch point properly aligned. Bolts can be drawn up tight without hindering the lateral movement of switch points.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL



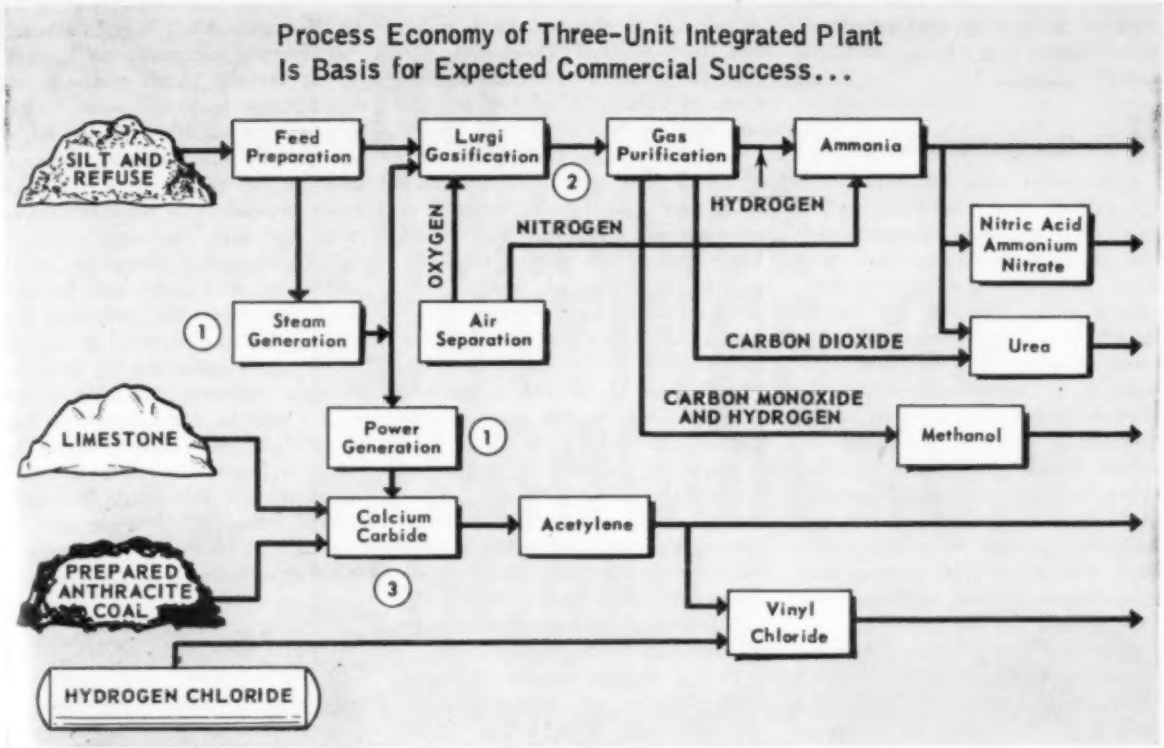
MARKETING RANGE of DRC plant will be about 300 mi as shown by circle on map. Prospective customers within this range account for some 40% of U. S. industrial consumption of chemicals.

Philadelphia & Reading and General Dynamics join forces as . . .

Anthracite Takes Lead in Making

Proposed formation of Dynamics Reading Chemicals, Inc., moves the direct manufacture of chemicals from coal closer to commercial reality. Plans call for building a $100 million anthracite-based plant near Pottsville, Pa. Here is why DRC planners see competitive success a near-sure bet.

HUGE MOUNTAINS of anthracite silt and refuse surround P & R's St. Nicholas breaker just north of Pottsville, Pa. Planned location for DRC plant is a short distance in the direction of arrow.



ANTHRACITE silt and refuse will be used (1) for generating steam and electric power, and (2) for Lurgi gasification process. Generated power will serve Lurgi unit and (3) electric-furnace production of carbide-acetylene.

Chemicals Directly from Coal

MAJOR COMMERCIAL progress in the manufacturer of chemicals directly from coal and the Nation's first commercial use of the Lurgi coal-to-gas process are now in the offing. Both prospects are wrapped up in the proposed formation of Dynamics Reading Chemicals, Inc., to build an integrated plant consisting of the following three units (note process diagram):

1. A power plant for burning anthracite silt and refuse to make electricity and steam for the integrated operation.

2. A Lurgi-type gasification and purification plant to make hydrogen and synthesis gas for producing ammonia, nitric acid, ammonium nitrate, urea, methanol and other chemical building blocks.

3. An electric furnace in which limestone and prepared anthracite would be roasted to produce carbide-acetylene, and subsequently, in an associated reaction with hydrogen chloride, vinyl chloride.

Formation of DRC is backed by the Philadelphia & Reading Corp., leading anthracite producer, and General Dynamics Corp., a top defense contractor, famed in the building of aircraft, missiles, nuclear submarines and electronics equipment.

The new corporation will build its integrated plant near Pottsville, Pa., field headquarters for P & R's subsidiary, Reading Anthracite Co. Bulk of the financing for the $100 million plant is to be arranged through P & R's and GD's bankers. Each of the parent companies will put up nominal amounts of working capital.

DRC planners view the opening up of the Pottsville area as an event comparable to the discovery of an important oil or gas field. They figure their new plant will be in a position to produce chemicals at a cost no greater than that prevailing in the Gulf Coast area where these chemicals are manufactured from oil and gas.

Including development and construction time, it should take some 3 yr to put the plant on the line. Observers close to the project say that initial production will be sold before the plant reaches the operating stage. Its output will be shipped to chemical processing companies for making a wide range of finished products including fertilizers, plastics, explosives, anti-freeze, insecticides, pharmaceuticals, synthetic fibers and, possibly, rocket fuel.

During the construction phase, the Pottsville region should gain substantially from added employment. Lasting economic aid here depends on the extent to which the DRC plant is able to attract "satellite" chemical companies. Some industry analysts expect the plant may also encourage other types of industrial

invasion, such as by steel companies, that might gain from anthracite usage.

DRC's Competitive Prospects

Commercial coal chemicals today are still produced indirectly as by-products of coke-oven operations. Several chemical companies have tried direct manufacture using only bituminous coals. But each has shelved its efforts, at least temporarily, because of technical or economic problems. In a similar boat, too, is the Consolidation Coal Co. which has led bituminous in coal chemicals research. The firm still looks to future years before it can put chemicals made from its low-temperature carbonization process on a competitive basis with those now coming from coke-oven operations, or those made from natural gas and petroleum.

No valid comparison exists between the above attempts to extract chemicals directly from bituminous and DRC's processes based on anthracite. These represent a new and completely different approach.

DRC will pin its prospects for competitive success to the following factors:

1. Proven technical and economic feasibility of using non-caking anthracite in a modified version of the basic Lurgi gasification process.
2. Plant location adjacent to a huge supply of anthracite silt-and-refuse fuel for making cheap electric power. Limestone is also abundantly available for use in the electric furnace operation.
3. Nearness to certain major chemical markets.
4. "Triple-play" use of hard coal in the electric furnace.

Proven technical and economic feasibility of using anthracite silt and refuse in the Lurgi process is based on full-scale tests made by P & R in commercial Lurgi gasification facilities of Steinkohlengas, AG, Dorsten, Germany. Independent engineering analysis by the Blaw-Knox Co. has confirmed this original evaluation.

DRC's use of the process will be the first commercial application in this country. Elsewhere, in addition to German installations, it has proven out commercially in South Africa, Australia and India. Notable are the Lurgi gasification facilities of the Sasol plant, South Africa, the world's first full-scale oil-from-coal plant (*Coal Age*, September, 1955, p 54) and the Morwell (Australia) gas-from-oil plant of the Gas & Fuel Corp. of Victoria (*Coal Age*, September, 1957, p 81).

Location of the DRC plant near Pottsville, Pa., puts it within close range of the largest concentration of anthracite silt and refuse banks in the U. S.—some 300 million tons. Expressed in terms of power, engineers estimate this is enough fuel to produce 2.5 billion kwhr of electricity annually for well over 50 yr. The payoff? Cost of the raw material is negligible but its Btu value is estimated at around $3 per ton.

Marketing advantages stem from the fact that about 40% of U. S. industrial consumption of chemicals takes place within a radius of 250 to 300 mi of Pottsville. This area encompasses the Delaware Valley, the New Jersey flats, Wilmington and parts of the Ohio River Valley.

In the electric furnace operation, DRC planners see another competitive advantage in achieving "triple-play" use of hard coal. These three uses are (note process diagram): (1) use of prepared sizes mixed with limestone in the electric furnace, (2) use of silt and refuse as feedstock to generate power, and (3) use of electrodes, made primarily of anthracite, in the electric furnace.

Anthracite Stake

In terms of new employment for the Pottsville region, a P & R spokesman points out that the area will benefit primarily during the construction phase of the project which is expected to last about 2 yr. Based on the project's quoted costs of $100 million, the construction payroll is put at about $50 million. When the project is completed, employment benefits will be cut sharply as "a plant based on the Lurgi process is largely automated and not known to be labor-intensive."

Real hopes for lasting economic aid are further in the future. These hopes are pinned to the strong possibility that the Dynamics Reading Chemicals operation might attract "satellite" chemical processing companies to the area. The prospect, furthermore, is no pipe dream; such an eventuality has happened before, notably in Calvert City, Ky. Here, a number of companies have built satellite operations in the vicinity of Air Reduction Co.'s acetylene plant.

If chemical companies are successful in moving plants near to anthracite raw materials, some industry observers say their success might also provide the necessary leverage to crack the steel market, now primarily dependent on bituminous. For years, anthracite has been researching and promoting greater use of its product by steel companies. By and large, however, the industry has never gotten much beyond selling relatively small quantities of fines for sintering purposes. Still hanging fire on the agenda, for example, is use of anthracite as a direct charge in the blast furnace to reduce iron ore —even though this usage has been proven technically feasible and is potentially attractive economically (*Coal Age*, May, 1956, p 60).

Newest Facet of P & R Growth

Regardless of what other benefits may follow, the proposed formation of Dynamics Reading Chemicals marks the newest facet of P & R's growth program, started Jan. 1, 1956 when Howard A. Newman assumed the presidency (*Coal Age*, February, 1957, p 94). Guided by Mr. Newman and a corps of astute management men, P & R has streamlined operations of its Reading Anthracite Co., has acquired four new money-making subsidiaries and has set a pace of profits-growth which is outstanding today among commercial enterprises of equivalent size.

The proposed DRC plant puts P & R on the verge of culminating a determined effort to make profitable use of its huge mountains of heretofore-unclaimed anthracite wastes.

P & R looks to General Dynamics for professional and marketing know-how in the new project. Management and sales responsibility will be under Rex L. Nicholson, president of this firm's Liquid Carbonics Div. General Dynamics sees the new project as an opportunity to further balance its heavy stake in government contracts with more commercial sales. Also, according to Schweickert & Co., investment brokers, N. Y. C., the firm is spurred by special interest in cheap production of hydrogen which, the Air Force has apparently recognized, may be the "ultimate chemical propellant" for rockets and space ships.

NO ABRASIVE CUTTINGS GO THROUGH THIS STOPER !

S20 "DUSTLESS" STOPER is the only practical stoper for 26-inch coal. It's shorter, lighter, more powerful than all other makes — can be used wherever a man can crawl.

LE ROI S20 "DUSTLESS" STOPER

Cuttings are removed through the hollow drill steel and the chuck housing — not through the stoper! That's a big tool- and cost-saving difference between the Le Roi S20 and other makes. And that's one reason why this light, short, and powerful stoper out-drills and outlasts all other makes — why it's preferred by operators.

Its efficient dust-collection lowers dust-count well below that of wet-drilling — permits faster, easier drilling. Since cuttings are kept out of the stoper, it needs less upkeep.

Ask your Le Roi distributor to explain how the S20 "Dustless" Stoper can help you save work and cut costs. For information, write to Le Roi Division, Westinghouse Air Brake Co., Milwaukee 1, Wis.

LE ROI NEWMATIC® AIR TOOLS

PORTABLE AND TRACTAIR AIR COMPRESSORS • STATIONARY AIR COMPRESSORS • AIR TOOLS

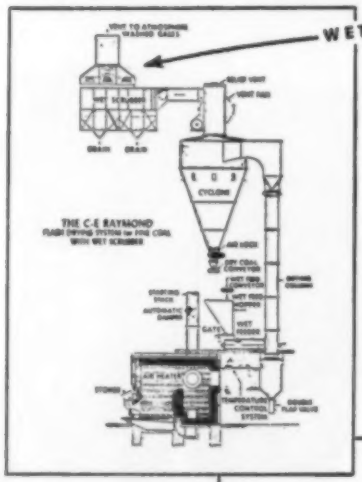
Distributed in the Coal Fields by: Acme Machinery Company, Huntington, West Virginia, and Equipment Service Company, Inc., Birmingham, Alabama.

AT-904

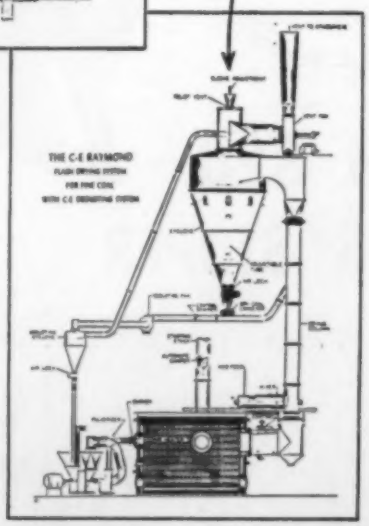
The Problem:

CONTROL OF AIR POLLUTION IN CLEANING FINE COAL

The Solution:



The Wet Scrubber shown above averages 90.7 collection efficiency, with vented air containing no more than 0.1 grain per cu. ft.



Dedusting System at right is proving its effectiveness in many installations, as in average feed of 8.2% thru 325 mesh, the finished dried coal product is only 1.3% of this nuisance material.

C-E RAYMOND FLASH DRYING SYSTEMS

. . . provide a high-efficiency method of drying fine coal in combination with modern type dust control units that comply with non-pollution regulations in restricted areas.

Two different units are available for this purpose: the Roto-Clone Type of Wet Scrubber for washing the vented gases to reduce dust loss . . . and the C-E Dedusting System that extracts the ultra-fine dust from the vent and burns it in the furnace to produce heat for drying.

Either type may be used according to conditions. Since C-E Raymond Equipment is *tailored* to the individual installation, all units are designed to fit the requirements of the plant, and conform to local smoke control ordinances.

• • •

COMPLETE SYSTEMS

C-E Raymond Flash Drying Equipment offers a complete, coordinated system for the rapid drying of fine coal ⅜" to 0, for large or small plants. Capacity ranges from 10 to 100 tons per hour per column—up to 4 columns per furnace.

It operates as a clean, safe, automatic system without coal degradation. It has high thermal efficiency with low operating and maintenance costs, due to minimum moving parts, and the use of air for both drying and conveying.

Write for
Coal Drying Bulletin

COMBUSTION ENGINEERING, INC.

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Raymond Division

Sales Offices in Principal Cities

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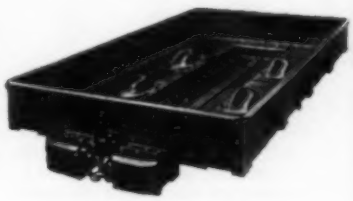
ENTERPRISE WHEEL & CAR CORPORATION

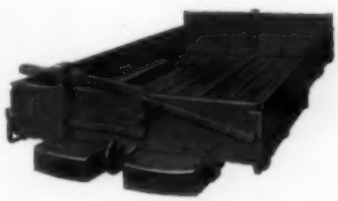
CUSTOM-ENGINEERED MINE CARS . . . .

ENTERPRISE CARS are built for the mine—*not for the shop*

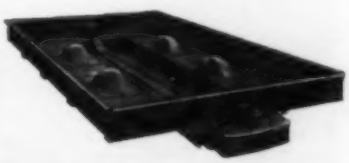


ENTERPRISE CARS are built to meet *every* mine specification

ENTERPRISE CARS give you *constant haulage* . . . no serious production delays. Repairs will not affect over-all mine operation



ENTERPRISE WHEELS are not made of ordinary cast iron. Enterprise wheels are made of chilled semi-steel—heat-treated for high tensile strength and shock resistance



ENTERPRISE TRUCKS can be furnished with either straight, tapered or ball bearings. In orders and inquiries, please include information regarding style truck, diameter of wheel and axle, track gauge, and wheel base

Your insurance against haulage delays and shut-downs . . .
. . . MINE CARS

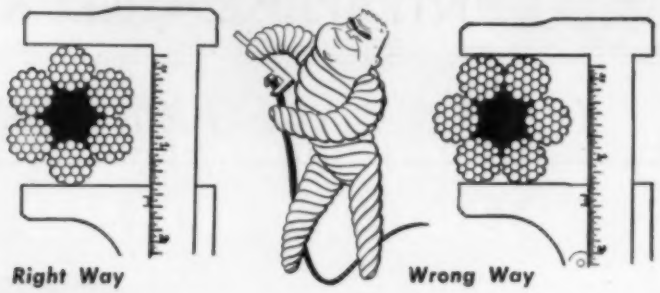
An experienced mine car engineering and production organization, backed by 60 years' experience, is at your disposal. Write us your haulage requirements and problems.

ENTERPRISE
WHEEL AND CAR CORPORATION
BRISTOL, VIRGINIA - TENNESSEE
HUNTINGTON, WEST VIRGINIA

Tuffy® Wire Rope Tips

When Sheaves, Sockets and Clips Misfit... Your Pocketbook Will Be Hard Hit

How to Measure Rope Diameter



To get the most service, efficiency and safety out of wire rope operation, rope and sheaves must be precisely fitted to each other. There's only one right way to measure rope diameter: use machinist's calipers and be sure to measure the **widest diameter.**

A slight shift of the rope in the calipers, as shown above, will give you a misreading which would result in ordering an undersize rope. Note that the measurement at right shows ⅛" under correct diameter. Be sure to double-check every time!

Tuffy Balanced Dragline Rope

Here's highest abrasive resistance with super flexibility. Better spooling. Smoother riding on grooves. And Tuffy Dragline Rope hugs the drum when casting for full load. Gives you longer service life, consistent dependability, in handling any material — wet or dry dirt, sand, gravel, rock, cement or minerals.

How to Check Groove Diameter

No Go

Just Go

Groove diameter of a sheave or drum must never be less than the actual calipered diameter of the new rope. When a new rope is installed on old equipment, use a reliable groove gauge to make sure the tread or bearing surface of all sheaves is of sufficient size to avoid pinching the rope.

Kick Out Worn Sheaves

Old sheaves may never die, but in "fading away" they develop conditions which shorten rope life. Sheaves with grooves corrugated with rope lay impressions should be replaced with new ones before new wire rope is installed.

How to Measure Tread Diameter

Easy, and important. Select the smallest sheave or drum to be used with the new wire rope, and measure actual diameter at lateral center (shortest dimension) of tread.

Tuffy Balanced Slings & Hoist Lines

"Balanced" because they combine strength, flexibility and toughness in the proper relationship to do a better job longer.

Tuffy Slings and Hoist Lines are a top-performing team in every type of materials handling. The slings are made of a patented, machine-braided fabric that's next to impossible to knot or kink. The hoist lines are a special construction in which strength, flexibility and toughness are balanced.

Tuffy Balanced Scraper Rope

"Balanced" construction makes it flexible enough to withstand sharp bends, yet stiff enough to resist looping and kinking when slack. Also gives higher resistance to the shock of load impact on slack line. Moves more yardage per foot because it's specially built to take the beating of drum-crushing abuse.

Tuffy Balanced Dozer Rope

Built to give you longer service with less downtime. Mounted on your dozer, a 150' reel of ½" or 9/16" can give you a big bonus of extra service. Here's how: when rope shows drum wear or is crushed on the drum, you feed through just enough to replace the damaged part. You save the 40 to 50 feet ordinarily thrown away. Also available in 300' and 500' reels.

Use the Right Fittings

Right fittings add life expectancy to wire rope. Fittings which derive holding power from crimping action are harmful.

Shown here is a clamp that has no "wrong side"—can be put on either way. It snugly saddles the rope, grips larger surface area in such a way that loads are carried almost entirely by friction instead of crimping action. Combined in its two parts is a thimble. The parts are interlocked to prevent collapse of the thimble and eliminate all shear on the bolts.

Recommended sizes:

Diameter of Rope	Min. Dia.	Max. Dia.
¼-⅜	+ 1/64"	+ 3/32"
⅜-¾	+ 3/32"	+ 1/16"
⅞-1⅛	+ 3/64"	+ 3/32"
1¼-1½	+ 1/16"	+ ⅛"
1⅝-2¼	+ 3/32"	+ 1/16"
2⅜ and larger	+ ⅛"	+ ¼"

New ropes are usually over-size. It is advisable to have groove diameters of sheaves or drums as large as the actual calipered diameter of the new rope, or slightly larger. We recommend sizes as above charted.

9 Steps to Correct Socketing

1. Securely seize and serve with soft wire ties before cutting, and have at least two additional seizings placed at a distance from the end equal to the length of the basket of the socket.
2. When the rope is properly seized, take off the end seizing. Cut the fiber center back to the seizing, as shown in 1 above. Untwist and broom out the wires. See illustration 2.
3. Clean the wires for the distance they are to be inserted in the socket. Use benzine, naphtha, gasoline or other solvent. Then wash off in boiling water or boiling ammonium chloride used in Step 5.
4. Then dip cleaned wires in commercial muriatic acid to a depth not greater than ¾ of the cleaned length of wire. Keep the wires immersed for 3 minutes, or until the acid has thoroughly etched each wire. Be sure acid does not contact any other portion of rope.
5. Immerse wires into boiling ammonium chloride. A white coating will be left on the wires.
6. Place a temporary tie wire over the ends of the cleaned wire (see illustration 3). Be careful not to get the cleaned wires greasy or oily.
7. Insert the rope end into bottom of socket. Remove temporary tie wire.
8. Holding the rope vertically in a vise, set the socket so that the wires are flush with top of the socket basket and seal the bottom with putty or clay (See illustration 4). Pour in among the wires about ½ teaspoon of sal ammoniac crystals.
9. Pour molten zinc into the basket until it is full (see illustration 5). When zinc is solidified, the seal is removed and socketing complete as shown in illustration 6. The zinc must not be too hot or it will anneal the wires, particularly of small ropes. Temperature must not be above 925° F. Use pine stick test: if stick chars but does not ignite, the zinc is ready to pour. Overheated zinc will have a red color and stick will catch fire. When zinc has solidified sufficiently, the socket may be plunged into cold water.

FREE!

Complete Splicing and Socketing Manual with engineer's notebook on wire rope constructions and specifications. Write for your copy now. Address Union Wire Rope Corporation, 2130 Manchester Ave., Kansas City 26, Missouri.

Specialists in high carbon wire, wire rope, braided wire fabric, stress-relieved wire and strand.

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You hear a lot about extra strength in wire rope. It's no trick to design rope with very high strength. The main thing is to get the proper balance of strength with other qualities needed.

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2

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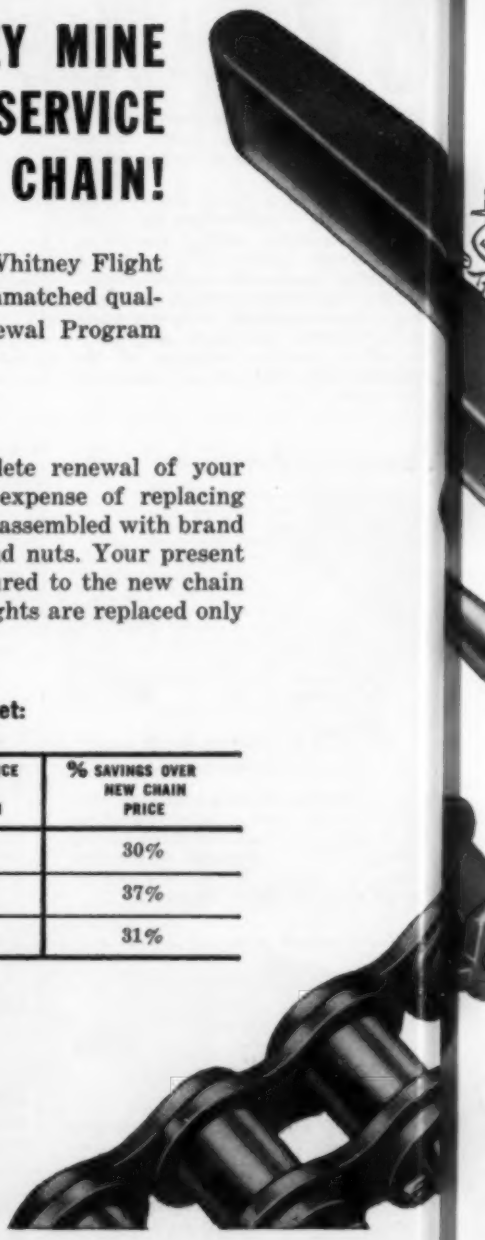
AVAILABLE ONLY TO WHITNEY MINE CHAIN USERS... FOR EXTRA SERVICE LIFE, MORE TONNAGE PER CHAIN!



You get double-barreled savings when you purchase Whitney Flight Conveyor Chain. First — economical *initial cost* and unmatched quality. Second — a real cost-saving *PLUS* in the Renewal Program provided by your Whitney Chain Distributor.

HERE'S HOW IT WORKS:

Whitney's exclusive construction allows complete renewal of your Whitney Flight Conveyor Chain without the expense of replacing the long-wearing flights. Your chain is carefully assembled with brand new factory chain sections, new flight studs and nuts. Your present flights are thoroughly inspected and firmly secured to the new chain sections, using factory torque specifications. Flights are replaced only when actually required.

Here's a few specific examples of the real savings you get:

CHAIN APPLICATION	MACHINE MAKERS PART NO.	* TOTAL PRICE OF RENEWED CHAIN	ORIGINAL PRICE OF NEW CHAIN	% SAVINGS OVER NEW CHAIN PRICE
1 CM Rear	X673-232	$427.75	$608.13	30%
14 BU Loader	A18960A-111	609.02	959.78	37%
11 BU Loader	11054A-254	872.77	1,260.61	31%

**THE ABOVE SCHEDULE DOES NOT INCLUDE A NOMINAL LABOR CHARGE*

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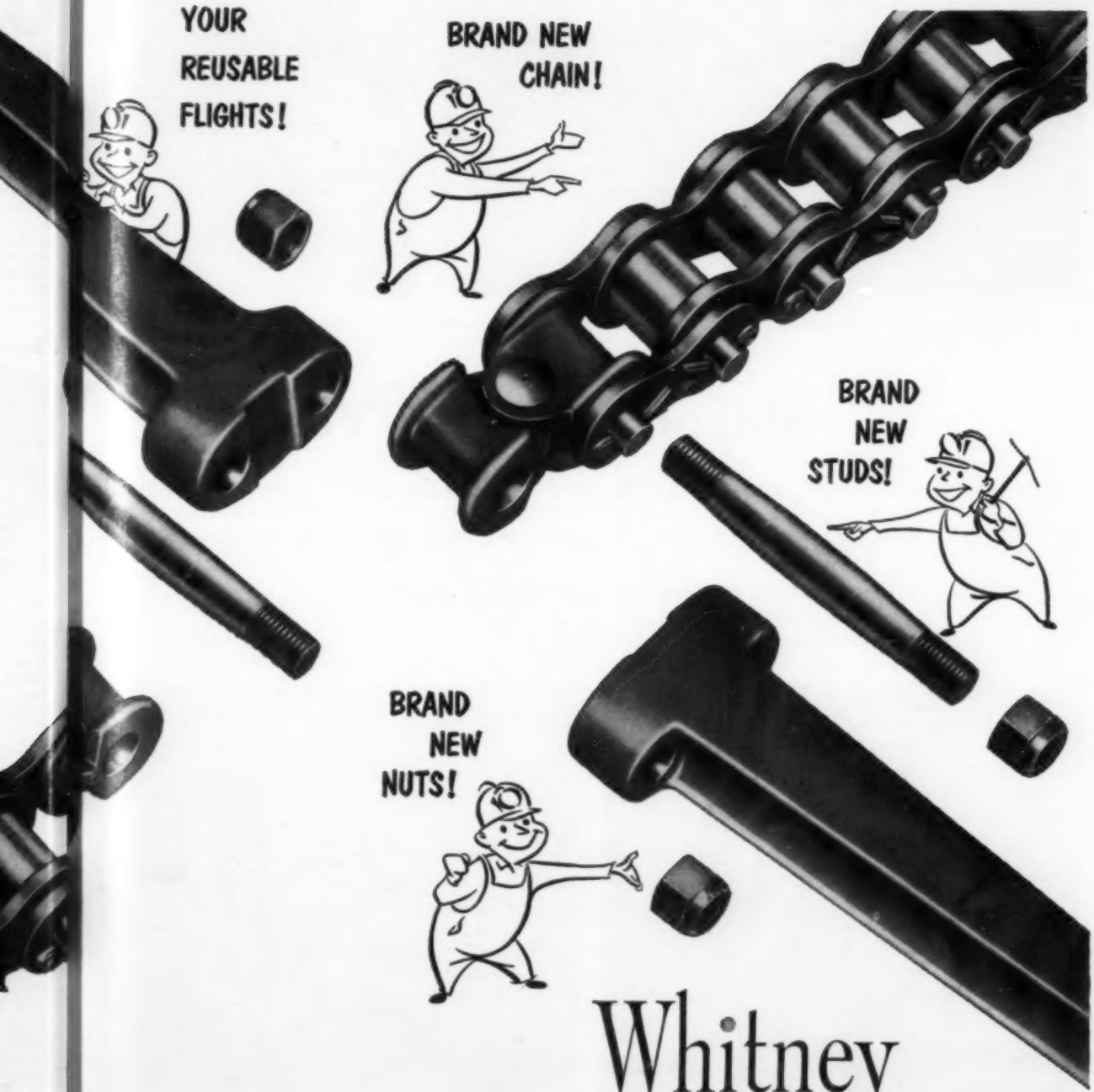

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ROLLER CHAIN • CONVEYOR CHAIN • SPROCKETS • FLEXIBLE COUPLINGS • WHITNEY-TORMAG DRIVES

70-YD SHOVEL removes 1,800,000 cu yd of overburden per month while working around the clock seven days a week at Ohio mine serving power plant. Unit is second of three similar excavators to be operated by Peabody.

Million Tons Per Year: Goal

Ohio's largest coal stripper moves 1,800,000 cu yd of overburden per month to expose 80,000 tons of coal at Simco Peabody's Coshocton mine. Overburden, drilled with a rotary dry-type unit, is broken with pre-packed ammonium-nitrate blasting agent.

RUBBER-MOUNTED tractor bulldozer, dwarfed by giant shovel, cleans up loose material as stripping unit moves ahead.

OVERBURDEN DRILL operates two shifts on roads cut into hillside. Machine sinks 10⅝-in holes on 27-ft centers.

PORTABLE magazines, towed by tractor, carry 50-lb bags of ammonium-nitrate-type blasting agent to drill site.

9-YD SHOVEL loads coal into 51-ton tractor-trailer haulers. Bulldozers help break up coal in sub-freezing weather.

for 70-Yd Coal Chief

ANOTHER 70-yd stripping giant is moving across the countryside gobbling up overburden in 105-ton bites every 45 sec. This latest of the 70-yd Marion 5760 stripping shovels, Simco Peabody's Coal Chief, works around the clock 6 mi south of Coshocton, Ohio, to uncover coal for the Columbus & Southern Ohio Electric Co.'s new power plant at Conesville.

A Marion 4161 electric shovel, swinging a 9-yd dipper, loads coal from the 44-in Ohio No. 6 seam into a fleet of Euclid 51-ton coal haulers that carry it 3 mi over company roads to the power plant's stockpile.

Simco Peabody operates the mine for the Columbus & Southern Ohio Electric Co. In 1958 the operation produced 357,252 tons which was burned for one 125,000-kw generator. The power company now has a second 125,000-kw generator on stream and coal loading has increased accordingly. Eventually Simco Peabody will be supplying over a million tons annually to the Conesville generator station. All of Simco Peabody's mining equipment was chosen with this goal in view.

Lynn Crump, superintendent, is directly in charge of Simco Peabody's Coshocton mine. His assistants include Robert Foreman, assistant superintendent; L. R. Reynolds, master mechanic; and W. F. Bourg, chief electrician.

The Big Shovel

The Coal Chief stands 147 ft 6 in above the ground at the tip of the boom, which is 49 deg with the horizontal. It is 103 ft 6 in from the ground to the top of the shovel's A-frame. It took 75 railroad cars to carry the various components from the factory to the mine site and it took skilled crews about 5 mo to assemble the unit.

Like Peabody's first 70-yd shovel at River King mine (*Coal Age*, January, 1958, p 76), the Coal Chief uses 7,200-V power. Power units and controls were supplied by General Electric.

To provide maximum strength with minimum weight, all-welded construction and high-strength alloys were used in the front end. For example, the dipper and handle are made of T-1 steel and the dipper teeth are 12M alloy. The bail and sheave blocks also are made of T-1 steel. In addition, the stiff leg, welded A-frame and boom are made of Tri-Ten alloy.

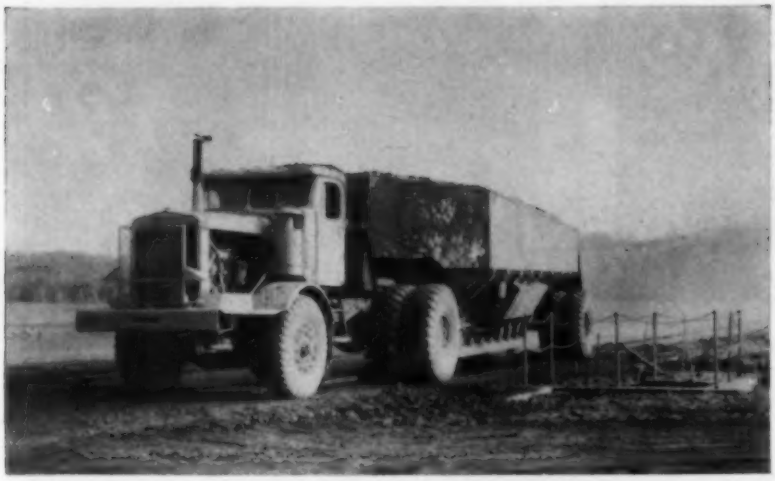
In keeping with the latest trend in shovel design, a pushbutton controlled elevator travels in a shaft passing through the hollow center journal. It may be stopped at any of three stations and can be operated without interfering with operation of the 70-yd shovel.

Drilling and Blasting

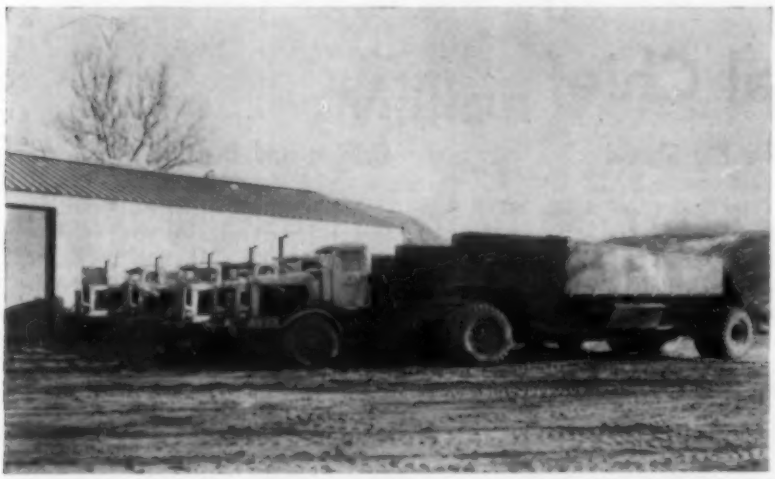
A Bucyrus-Erie 50-R electrically powered vertical dry-type machine equipped with a Hughes W7RJ bit sinks 10⅝-in blastholes on 27-ft centers. If several rows are needed they are spaced 27 ft apart and holes are drilled in staggered pattern. The 50-R unit sinks an average of 625 ft of blasthole per shift. Bit life averages 13,704 ft.

Overburden is broken with Austin AL15 ammonium-nitrate-type blasting agent, which is delivered to the mine in 8-in 50-lb polyethylene bags by trailers. The trailers carry 30,000 lb and are parked at a central location where portable rubber-tired field magazines towed by bulldozers can be loaded conveniently. Each portable magazine holds 5,000 lb and is towed to the drill site where the AL15 can be unloaded near the holes to be charged.

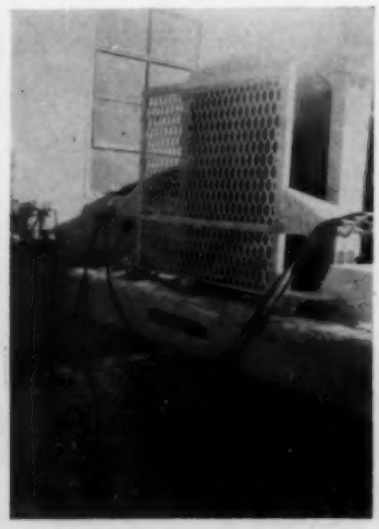
Multiple-deck loading is practiced to provide the best fragmentation with a minimum of explosives. Simco Peabody's aim is to break 3½ cu yd of bank with each pound of explosive. If the overburden is 45 ft or less, single-deck loading is practiced; if 47 to 70 ft thick, 2-deck loading; if 70 to 100 ft thick, 3-deck loading; and if more than 100 ft thick, 4-deck loading. A 12½-lb primer of Austin AL4 is used in each deck.



DESTINATION of coal is power plant's 500-ton storage bin 3 mi from mine. Bin feeds crushing and stockpiling equipment owned by power plant.



COAL HAULERS are parked outside of shop at end of loading shift. Electric engine heaters, plugged in by drivers, keep water temperature at 120 deg. Power outlets for heaters are mounted on outside of shop wall.



Since most of the cover ranges between 45 and 70 ft in thickness, double-deck loading is predominant. The charge in a double-decked hole consists of 350 to 550 lb of explosives, depending on the depth of the hole. A three-deck charge totals better than 550 lb.

Holes are laced with Ensign Bickford and Austin detonating fuse and 17-MS delay connectors are used between holes. If more than one row of holes are loaded, 9-MS delay connectors are used between rows.

Blastholes usually are charged as they are drilled on the first and second shifts. One man on the first and second shifts devotes full time to loading explosives. He is assisted as needed by members of the drill crew. Once each day, usually after the start of the second shift, a group of holes is shot.

Removing Overburden

Working around the clock seven days a week the Coal Chief uncovers a 100-ft strip of coal in average first-cut work and as much as 135-ft in favorable conditions. On inside turns, pit width is reduced to 75 ft. In second-cut stripping pit width is reduced because of rapidly increasing thickness of cover. A Michigan 180 TD rubber-mounted tractor-bulldozer works in the pit beside the 70-yd shovel to clean up loose material.

To uncover 1 ton of coal, the Coal Chief removes an average of 22 cu yd of overburden. The 70-yd stripper handles 1,800,000 cu yd of overburden each month and exposes 70,000 to 80,000 tons of coal. This stripping capacity provides the coal necessary to fuel the boilers of the two 125,000-kw generators of the power plant.

Loading and Hauling

A Marion 4160 electric shovel with a 9-yd dipper loads coal into a fleet of five Euclid 51-ton dropbottom semi trailer coalhaulers. Tractors are powered by Cummins NRTO 335-hp engines with turbochargers and PT fuel systems and have Fuller R1150 Roadranger transmissions. They also have power steering and a Lincoln centralized lubrication system.

The coal haulers carry coal 3 mi over company roads to a 500-ton bin at the power plant's stockpiling area.

Coal is elevated to a rotary breaker, reduced to 1¼ in top size and then carried to a crusher for reduction to ¼ in before flowing to the stockpile. Crushing, conveying and stockpiling facilities are operated by the power company.

Power and Maintenance

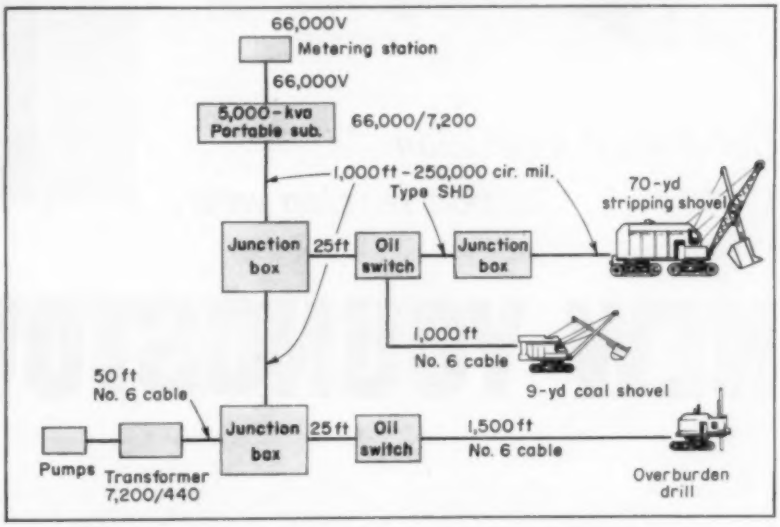
Power is delivered to the mine at 66,000 V and metered before entering a General Electric 5,000-kva skid-mounted portable substation that reduces voltage to 7,200 for company use. The skid-mounted unit is a complete package, including relays, oil switches and ground protection. The company also has an auxiliary 500-kva transformer substation to supply power for the overburden drill and loading shovel when they are working a long distance from the main substation and the 70-yd stripping shovel.

Power is carried to the pit by 1,000 ft sections of General Cable 250,000-cir mil Type SHD cable joined by Atkinson junction boxes. The company has six sections of cable and after these are in service the substation is moved up. Junction boxes have disconnect switches at each of three outlets so that power to individual machines may be disconnected without affecting operation of others.

The grounding system is set to operate at 10 amp on the primary side of the circuit and 3 amp on the secondary. This is achieved with a special current transformer & current-limiting resistor. Any time a ground comes on the system the circuit stays out until the trouble is located and repaired. Furthermore, if the circuit breaker should fail, protective equipment at the main substation would break the circuit.

Simco Peabody stresses preventive maintenance in keeping equipment failures to a minimum. To spot minor troubles before they have a chance to develop into a breakdown maintenance men make a regular, systematic inspection of all machines. For example, if they detect weaknesses while equipment is running they repair it during the lunch period. Or if they see that a major component of a machine is nearing the end of its life replacement is scheduled for the following weekend. Thus emergency equipment repairs are kept to a minimum.

MINE SUPERVISORS include L. R. Reynolds (seated, left), master mechanic; Robert Foreman, assistant superintendent; Lynn Crump, superintendent; W. F. Bourg (rear, standing), chief electrician; and Henry List, truck supervisor, all mines.



HOW Simco-Peabody distributes power to strip-mining equipment.

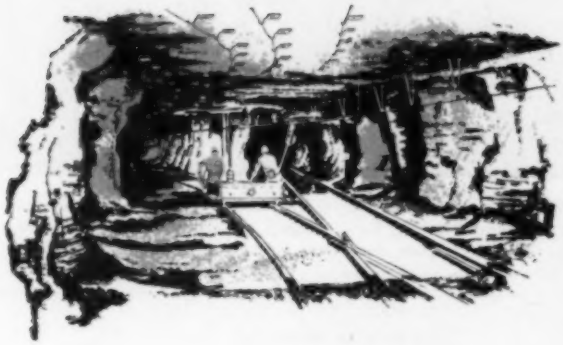
Engine Heaters

To simplify cold-weather starting of truck engines, each engine has its own Kim "Hot Start" electric engine heater. These units keep the engines warm while they are parked outside the shop on nonloading shifts.

The heater has an aluminum jacket enclosing a 2,500-W heating element and with two openings that connect to the engine's cooling system. At the end of a working shift, each driver parks his 51-ton coal hauler beside the shop. He then takes a length of power cable and connects the heater to one of the all-weather electrical outlets mounted on the outside of the shop wall.

The heater keeps the engine water temperature at about 120 deg. As a result, little or no difficulty is experienced in starting the engines during sub-zero weather. When drivers report for work they disconnect the power cable, check the oil and then start the prewarmed engine and immediately head for the pit without the warmup time required when no heaters are employed. Coal hauling also begins earlier.

Simco Peabody's maintenance staff includes one mechanic and four welders who are assisted by crew members of the unit being repaired. In addition, truck drivers help with maintenance work on days when coal is not loaded.



Get instant indication
of bolt tension with . . .

NEW YOUNGSTOWN VTI*

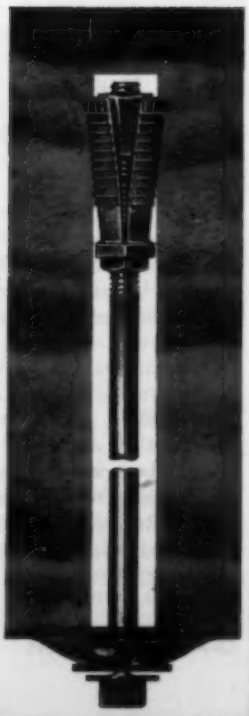
Youngstown VTI Mine Roof Bolts are available in ⅝ and ¾-inch diameters, 28 to 84 inches in length with 3¼-inch rolled threads.

Youngstown Mine Roof Bolts—with either standard or VTI heads—are available with self-supporting and non-self-supporting expansion shells.

You'll find a Youngstown VTI Mine Roof Bolt to fit any roof condition encountered in today's high-production mines.

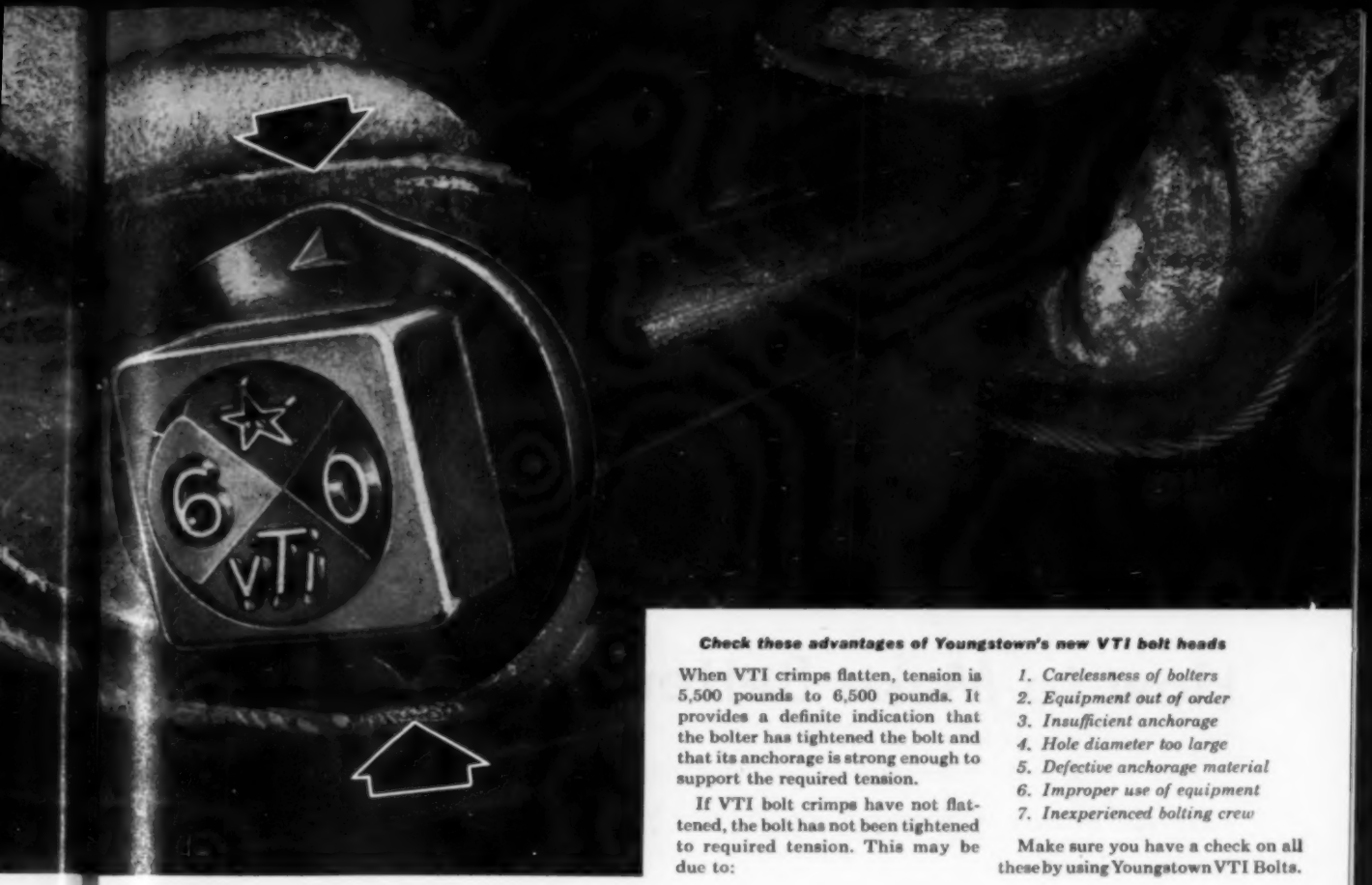
Physical properties of all Youngstown VTI Roof Bolts easily meet or exceed Specification ASTMA-306 as outlined by the Committee on Roof Action.

Take advantage of the highest standards of *quality*—the personal touch in our metallurgical *service* by specifying Youngstown VTI Mine Roof Bolts for your next roof-support job. For additional information, call or write today to our Home Office at Youngstown 1, Ohio.



How the Youngstown VTI bolt guarantees safe roof practice

Shown at right is a VTI Roof Bolt with a non-self-supporting expansion shell, pal nut, and a bell-type roof plate with hardened washer. When tightened with impact wrench, the VTI crimp flattens at between 5,500 and 6,500 pounds tension. No crimp means a safe roof.



Check these advantages of Youngstown's new VTI bolt heads

When VTI crimps flatten, tension is 5,500 pounds to 6,500 pounds. It provides a definite indication that the bolter has tightened the bolt and that its anchorage is strong enough to support the required tension.

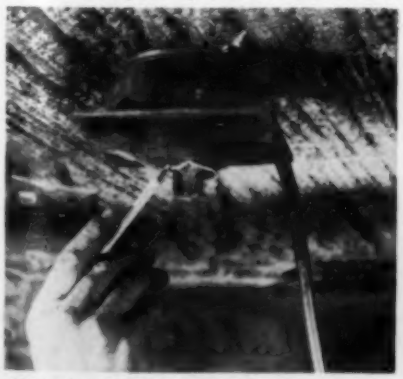
If VTI bolt crimps have not flattened, the bolt has not been tightened to required tension. This may be due to:

1. *Carelessness of bolters*
2. *Equipment out of order*
3. *Insufficient anchorage*
4. *Hole diameter too large*
5. *Defective anchorage material*
6. *Improper use of equipment*
7. *Inexperienced bolting crew*

Make sure you have a check on all these by using Youngstown VTI Bolts.

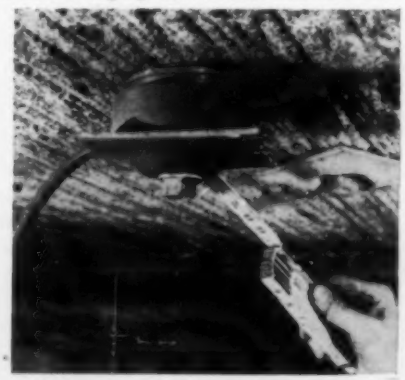
MINE ROOF BOLTS

At the Nemacolin Mine of Buckeye Coal Co., Nemacolin, Pa., tests were recently conducted on ¾-inch VTI Roof Bolts by the United States Bureau of Mines. They clearly show how the VTI feature provides a simple, fool-proof and economic means of assuring a predetermined minimum load.



VTI Bolt head showing crimping prior to loading. Air cylinder for tension testing is placed between roof and bolt plate.

Bolt head—loaded to 5,000 pounds—shows crimp beginning to flatten (note gauge reading).



At 6,100 pounds, crimp flattens completely.

**Youngstown VTI Mine Roof Bolt Patent Pending.*

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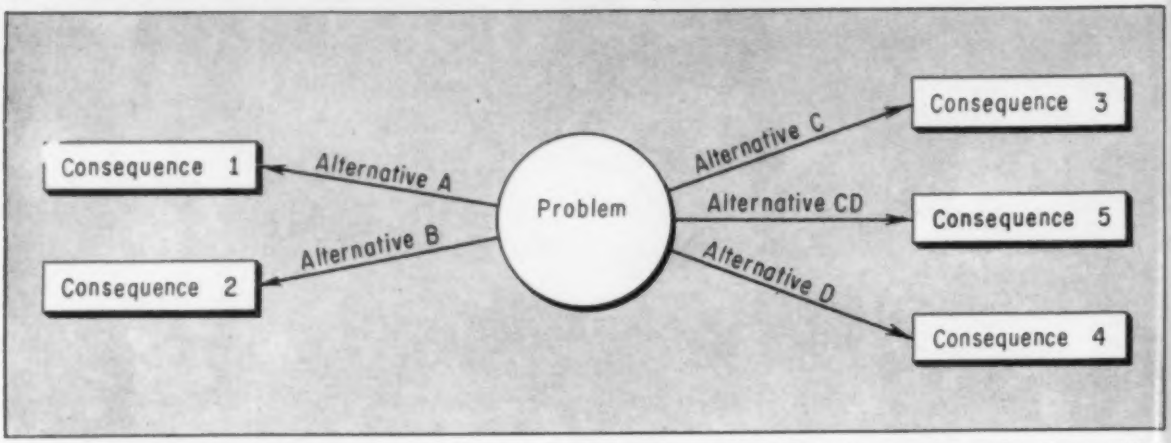
SHEET AND TUBE COMPANY • *Youngstown, Ohio*

Manufacturers of Carbon, Alloy and Yoloy Steel



DEFINING ALTERNATIVES and consequences of each is basic to problem-solving. Alternatives may be combined or modified into new separate ones as in "CD" above. Sometimes these prove to be the best answer for achieving goals.

How to Make Better Decisions

Take a look at the basic steps in decision-making. Through study and practice of them you can improve your skill in problem-solving.

By **Harold Durrett**
Personnel Manager, Hanna Coal Co.
Moundsville, W. Va.

"IF I COULD ONLY DO IT OVER!" This agonized exclamation is almost invariably the product of a poor decision. All of us have uttered it, because all of us have made poor decisions.

It is generally conceded that hindsight is better than foresight, but there is nothing to prevent improving our decision-making ability and foresight, just as any other skill, through study and practice. It is true, of course, that we cannot hope to perfect the art, but we can improve batting averages. Making decisions is the most important aspect of any supervisory job, and if a supervisor would be successful, he must continually endeavor to improve his decision-making skill.

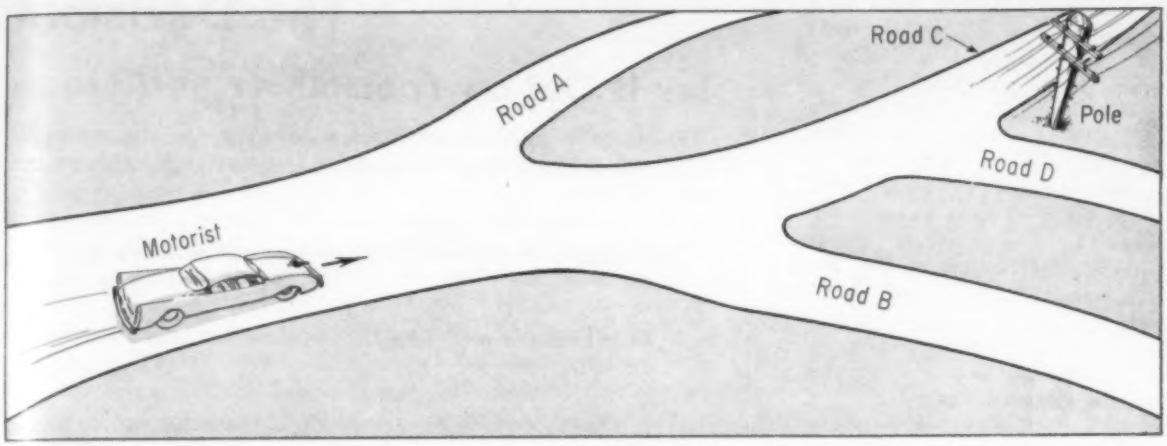
Now the question arises, "What is a decision?" There are many definitions and points of view on this question. Theoretically, all conscious, voluntary behavior constitutes decision making. For example, you are right now deciding whether to continue reading this article, whether to cross your legs, whether to clear your throat, whether to turn this page, etc. We all continually choose from behavioral alternatives, and thus make thousands of decisions each day. We even decide to decide, when to decide, or perhaps not to decide at all. Decisions are a function of living and cannot be avoided. These little decisions, unconscious and dominated by habit, are not the ones of primary concern here.

Rather we are concerned with decisions involving problems of psychological conflict between two or more alternatives, which are mutually exclusive (note diagram above). That is, confronted with a problem, we must choose between two or more courses of possible action, each of which precludes choice of the other. This does not mean that alternatives cannot be combined or modified, but such combinations or modifications must be considered new, separate alternatives.

There are several possible ways

About the Author . . .

HAROLD L. DURRETT has been personnel manager, Hanna Coal Co., Moundsville, W. Va., since September 1, 1956. Currently, "Hal" is experimenting in the use of psychological tests for selecting personnel. Active duty with the U. S. Army, 1947-54, brought him various personnel assignments in Korea and the U. S., and 4 yr as paratrooper with the 82nd Airborne Div.; he now serves in the reserves as captain, Adjutant General's Corps. Other work experience has included teaching psychology at West Virginia University and a number of odd jobs, concurrent with school attendance, such as farm hand, railroad section laborer, timber cutter and grocery clerk. "Hal" was valedictorian of his high school class and was elected to Phi Beta Kappa after graduation from West Virginia University, 1955, with an A. B. in psychology. In the near future, he expects to complete requirements for an M. A. in the same subject at the same university.



TIMING of decisions is relative. Generally, decisions are most effective when problems are anticipated. This does not, however, always mean much time. Motorist (above) for example, must act before reaching pole.

to describe the steps involved in the decision-making process. Here we shall consider the process to include:

1. Recognizing and defining the problem
2. Finding facts
3. Identifying alternatives
4. Making the decision

Actually, of course, these steps are intermingled and interdependent, but it will help if we consider each independently.

Recognizing and Defining the Problem

At first, it may appear senseless to talk about recognizing the problem in decision making, since no decision would be required if the problem weren't recognized. However, it often happens that decisions are made with only a vague awareness of the problem. Sometimes we recognize only a small part or restricted aspect of a problem and make a decision concerning it, when we could have acted differently had we been aware of the whole problem. Consider, for example, the following case:

Maintenance - Foreman Jones learns that one of his mechanics has neglected to lubricate some machinery, causing a serious mechanical breakdown. He may decide, without being aware that he is making a decison, to fire the mechanic. Or he may determine that his problem is what to do with the offender, with a goal of preventing future occurrences. His decision in this case might quite logically be to discharge, reprimand or reassign the mechanic.

Had he investigated further, Jones might find that his real problem is a poorly organized and supervised department in which employees are given conflicting assignments and inadequate instructions and training. His goal then would probably be to revamp his department so that supervision, training, instructions and inspection were adequate to ensure efficient functioning of the department. In this case, the decision indicated would be quite different.

Thus, the first essential in making an effective decision is to formulate the actual problem in clear, concise terms. Too often, we make important decisions without first determining what the problem is. The case of Foreman Jones shows how this approach can adversely affect goal-setting.

When one is required to make a decision, he is always seeking a route to a goal which will solve his problem. When the problem is recognized, the goal is usually apparent but make a practice of specifying it exactly. Goals may involve people, things, ideas, feelings, money, and the like, or combinations of these. In most cases, there are many little subgoals which together constitute the overall objective. The supervisor is often required to modify or rearrange the goal of his decision to make it attainable. Before choosing a route to goals, scrutinize them to be sure they are realistic and attainable.

Finding Facts

Once a problem has been formulated and clearly defined, the next step in decision making is to assimilate pertinent facts. Optimally, all facts having any bearing on the problem should be accumulated. Practically, of course, this is impossible. Some facts may have so little bearing that they are not worth the effort required to collect them. In many cases, the information needed is simply not available.

A good approach in assimilating information is to write down or make a mental note of all data needed, fact by fact, disregarding whether or not the material is available. Then proceed to collect, from all available sources, all facts which can practically be obtained. Where facts are impossible or impractical to collect, make assumptions for the missing information. Much skill in decision making is usually due to an individual's ability to bat a good average with assumptions.

In the fact-gathering stage of the decision-making process, a primary source of confusion is dealing with value judgments, or information which is not quantifiable. Suppose, for example, that you were selecting an office receptionist, and that two qualifications desired were youth and personal attractiveness. Suppose you had two applicants, one of whom was 35 yr old and the other 20. How much more attractive would the 35-yr old applicant have to be than her competitor to offset the difference in their ages? There is no

precise answer because there is no way to express degrees of beauty. Much information, as in evaluating beauty, is not quantifiable.

Worth noting are some common sources of facts required in making industrial decisions. Facts are frequently obtained by contact with others, by direct observation, by reference to files, records, reports, books, and publications, or they may be reasoned out by logical deduction. The source is unimportant as long as the user satisfies himself that he is collecting facts and not just someone else's assumptions.

Identifying Alternatives

Essentially, decision making is predicting consequences of a choice between alternatives (note diagram p 114). One says to himself: If I choose course "A" then "1" will result; if I choose course "B" then "2" will be the consequence; since "2" is closer to the goal I have set than "1", I will choose course "B."

As previously mentioned, decision-making requires mutually exclusive alternatives. Most problems offer a variety of alternatives or possible courses of action. An important step in the decision-making process is to identify all feasible courses of action. At least two alternatives will immediately present themselves in every case. It is usually advisable, though, to seek all other possible solutions or consider combinations of those recognized into still other alternatives.

The Decision-

Try It Out on Yourself

1. Choose a problem in your job on which you have not yet reached a decision. State the problem clearly and concisely below.

2. What goal do you wish to attain by solution of this problem?

3. What biases or prejudices do you have that might affect your decision on the matter?

4. List all the facts you will need to reach this decision, disregarding whether or not they are available. Supply the facts you now have, indicate where you will obtain the other facts if possible, and make assumptions for facts it will be impossible or impractical to obtain.

5. Identify all the alternatives or courses of action which you think are available.

6. Will the time when this decision is made be important? If so, why?

7. Considering all the facts listed in "4" and the information in "3" and "6," decide which of the alternatives in "5" will help you achieve the goal expressed in "2"?

Making the Decision

When the problem has been recognized and the goal of solution specified, the facts gathered and assumptions made, the alternatives identified and the consequences of each predicted, one might expect to be in a position to reach a decision. If only it were that simple! This is a much oversimplified analysis of the steps involved in the process, of course. Let's give some *thought* to other considerations which must be made.

Timing—Since a decision is relative and interacts continuously with the situation in which it is made, a good sense of timing on the part of the supervisor is essential. The best decision today may be the poorest tomorrow. The best decision today may be to make no decision until next week. The total situation must be considered to time decisions effectively. Generally, the farther in advance one can anticipate his problems and begin work on them, the more effective his decisions will be. This is true because more time can be allowed for the process and because more alternatives are available. The longer we delay recognizing the problem, the more restricted our choices are likely to be.

To demonstrate the adverse consequences of continued indecision, note the case of a confused motorist (diagram p 115) driving along a highway wondering which road to take. To make the analogy more realistic, let's say this motorist cannot turn back nor control the speed of his car. (We cannot reverse time nor control the rate at which it passes in our industrial life.) If, before reaching road "A," this motorist decides what his course will be to reach the goal he has set, he can choose any of the four roads which facts indicate will be his best course. If he passes roads "A" and "B" before reaching a decision, two of four possible courses are excluded. If he reaches the intersection of roads "C" and "D" and is still undecided, he will likely crash into the pole.

One is reminded here of the donkey who stood between two hay stacks and starved to death because he couldn't decide which looked more appetizing.

Making Process . . .

Apply It in This Case

You are Cole Hogg, mine superintendent, Snafu Mine, Hardly, Able and Dolittle Coal Co. Your general foreman, Firam Awl, is an excellent mining man and is, as far as you can determine, the best available man for the job. He was promoted to his present position 2 yr ago. His only shortcoming has been that he doesn't seem to understand human nature, and he has created many petty grievance cases by his abrupt handling of employees. He has incurred the wrath of the local union by his indiscretion, and despite all your coaching and efforts to train him, he just can't seem to keep from creating labor relations cases. It has fallen your lot to placate aggrieved employees and irate mine committees almost daily. Your boss, Titus A. Drum, has directed you to either replace Awl or to straighten him out.

Yesterday, Awl discharged four employees for so-called "horseplay" in the mine. They were Rex Karz, a motorman; Lowzie Mason, a bratticeman; Noah Count and Duno Moore, general laborers. You investigated this case, fearing that Awl may have gone off half-cocked again, and discuss the details with Hiram Goode, the personnel director. Goode advises that, based on the contract, precedents in this type of case and the evidence concerning the conduct of the men, you have about a 50-50 chance of making the charges stick if the union contests them.

You are now seated in your office. The mine committee, composed of I. M. Sharpe, Duit Wright and Les Strike, walks in. I. M. Sharpe, the spokesman demands that you reinstate the discharged employees and that you pay them for the time they have lost.

Assuming that the facts stated constitute all the information you have, what would you tell the committee?

These are ridiculous examples of the consequences of indecision, and we do not take them seriously. Many supervisory failures, however, are failures because they commit the same type of error—they cannot decide when to decide.

Prejudices, Biases and Emotions—Many decisions can be classified as emotional decisions. That is, emotions and feelings can contaminate facts and alternatives to the extent that decisions will obscure objective facts. Typical was the thinking of Maintenance-Foreman Jones who was going to discharge the mechanic without full investigation of the problem involved. We have all been advised to be objective in job performance. Intellectual decisions would, of course, be best. Unfortunately however, it is impossible to separate the individual from his emotions. No man can completely avoid having some of his decisions affected by feelings.

In making decisions, the only way to minimize biases and prejudices is to recognize them for what they are. This is a difficult and painful undertaking because most of our biases and prejudices satisfy deep-seated psychological needs. To recognize an attitude or opinion as prejudiced diminishes the satisfaction derived from holding it and makes us uncomfortable. If we sincerely want to reach effective decisions, however, we would all do well to practice identifying biases.

It is also advisable to consider the biases, prejudices and emotions of others in predicting their reactions to our behavior. This is especially important in decisions concerning people, which constitute a majority of those made by industrial supervisors.

Once an important tentative decision has been reached, it is usually best to test it before taking action. One good way of doing this is to present it to other supervisors or staff personnel for their opinions. Their response may indicate facts or alternatives which had not been considered, or may shed a different light on the problem.

Quick Decisions

This analysis may cause confusion in the mind of the supervisor confronted with the necessity of making a quick decision. He may wonder: "How is it possible to evolve a decision through this step-by-step procedure when only minutes or seconds are available before my indecision can lead to disastrous consequences?" Analogically, our motorist has reached the point of impact with the pole at the intersection when he becomes aware of his problem.

Regardless of the time allowed, an effective decision embodies the same basic elements. The supervisor faced with a problem requiring an immediate decision must still consider those facts he has, assume those he hasn't, identify alternatives, and select the course of action most likely to lead to his objective. By study and analysis, he can learn to synthesize these basic elements and to reduce considerably the time required to reach an effective decision. His study of the process should be instrumental in causing him to consider that one fact, or see that one alternative making the difference between a good and a poor decision.

Skill at decision making can be acquired only at the expense of hard work and practice. We should not be discouraged at, nor fixate upon previous errors, but we certainly must profit from them. Acceptance of a supervisory role in industry constitutes acceptance of responsibility for decisions. By being openminded, anticipating and defining problems, gathering facts and identifying alternatives, we can make better decisions.

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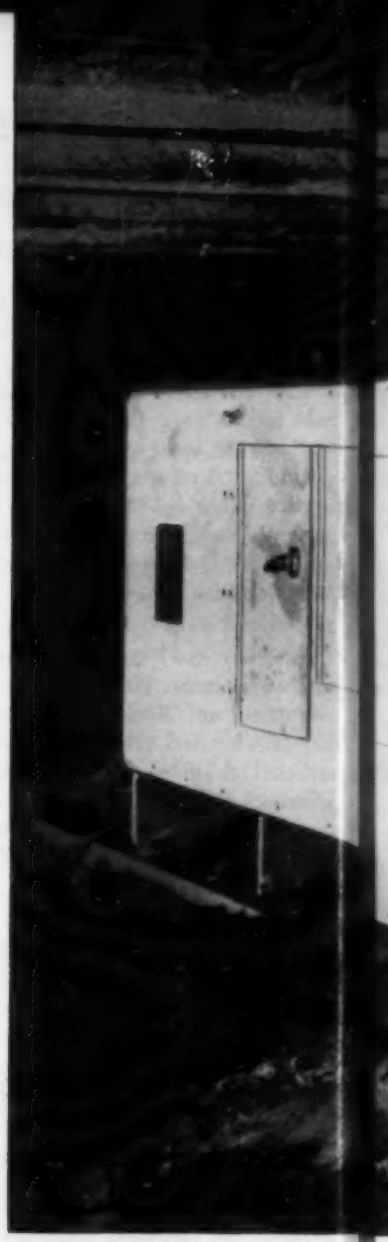

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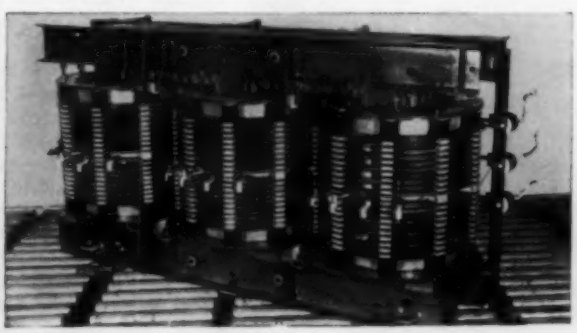
Core and coil assembly for 600-kva, 7200/480-volt, 3-phase unit—world's largest sealed mine power center made by Westinghouse.



NCA Charts New Course

42nd annual meeting amends association's charter and by-laws to expedite industry growth. Competition, national fuels policy, BCI progress, the role of the National Coal Policy Conference, and exporters problems are discussed.

Serving on NCA's New Management Team . . .

F. STILLMAN ELFRED was elected chairman, NCA board of directors—top membership office under the revised charter. Since April, 1958, Mr. Elfred has been chairman of the board, Peabody Coal Co. He was general manager, Explosives Div., Olin Industries, Alton, Ill., and, from 1952 to 1957, executive vice president, Olin Industries and Olin-Mathieson Chemical Corp., N.Y.C. Mr. Elfred is now a director of Olin-Mathieson Chemical Corp. and the Great Western Railroad. The NCA board chairman, a native of Denver, received an honorary degree from the Missouri School of Mines and an honorary doctorate in 1955. Memberships include the American Institute of Mining and Metallurgy, and the American Ordnance Assn.

R. L. IRELAND, chairman, executive committee, Consolidation Coal Co., is now vice chairman of the NCA board.

GEORGE E. ENOS, president, Enos Coal Mining Co., NCA treasurer.

ACTIONS AND PLANS to step up industry progress dominated sessions of the 42nd Anniversary Convention of the National Coal Association and the 14th Anniversary Convention of the Coal Exporters Association of the United States, Inc., held jointly at the Shoreham Hotel, Wash., D. C., June 3-5. Following are meeting highlights including a roundup of NCA's reorganization, abstracts from principal talks, and two panels: "What NCA Committees Are Saying (p 122)," and "Exporters Assess Outlook (p 121)":

NCA Reorganization

Topping NCA's business agenda were adoption of a revised charter and by-laws and election of a new board of directors.

The new charter and by-laws will permit a merger with other industry associations. Henceforth, there will be two classes of members:

1. Voting producer-members representing companies engaged in coal production.

2. Non-voting associate members representing interests allied with coal producers.

Under the revised charter, NCA's highest elective officers are chairman and vice chairman of the board of directors. The professional staff will be headed by a paid president. Previously, the title of president was held by an unpaid coal company executive, and the staff was headed by an executive vice president, a salaried official.

George E. Enos, president, Enos Coal Mining Co., continued as treasurer, a post he held under the previous charter. Tom Howarth was reelected secretary-assistant treasurer. The Board will subsequently elect a paid president and the other officers.

To head up its new board of directors as chairman, NCA elected F. Stillman Elfred, chairman of the board, Peabody Coal Co. He replaces Frank F. Kolbe, president, United Electric Coal Cos. and retiring NCA president, an office corresponding to chairman of the board under the new charter.

NCA's paid president, when elected, and Mr. Kolbe will serve as ex-officio board members. The balance of the 37-man board includes 20 members chosen on a geographical basis and 15 picked at large. Directors-at-large are as follows:

R. E. Salvati, president, Island Creek Coal Co.

F. S. Elfred, chairman of the board, Peabody Coal Co.

H. C. Livingston, president, Traux-Traer Coal Co.

David L. Francis, president, Princess Coals, Inc.

W. S. Webster, president, Snow Hill Coal Corp.

A. R. Matthews, president, Consolidation Coal Co.

Huston St. Clair, president, Jewell Ridge Coal Corp.

D. W. Buchanan Jr., president, Old Ben Coal Corp.

William H. Ritter, president, Reitz Coal Co.

John L. Kemmerer Jr., chairman of the board, Wise Coal & Coke Co.

J. R. Maust, chairman of the board, Tioga Coal Corp.

Stuart Colnon, president, Bell & Zoller Coal Co.

S. F. Sherwood, president, Sherwood-Templeton Coal Co.

Newton H. DeBardeleben, president, DeBardeleben Coal Corp.

Norman E. Kelb, president, Ayrshire Collieries Corp.

Year of Distinction

Frank F. Kolbe, president, National Coal Association; president, United Electric Cos.

This has been the most important year in the Association's life for two reasons. The first reason is the progress achieved for coal in official Washington. The second is that during the past several months we have undertaken a reorganization plan which will result in great advantages for the entire coal industry.

During the past year, coal has achieved important gains in controlling imports of residual oil, in limiting TVA territorial expansion, in restraining sub-

INDUSTRY MEETING—
A special COAL AGE
Staff-Written Report

sidization of atomic generated atomic power, and towards creating a federal coal research commission. Objectives achieved include repeal of the 4c-per-ton transportation tax on coal, a redefinition of the term "property" in computing depletion allowances, and favorable FPC decisions denying boiler use of gas to certain utilities.

Coal has also made significant progress through the accomplishments of Bituminous Coal Institute, through improved industry forecasting to cover 5-yr periods and through aggressive, expanded public relations activities.

What we have accomplished in the past year is due to the cooperation of everyone interested in coal, and where we have had common interests, to work with oil and gas producers. We have brought together the combined strength of everyone who is interested in coal's welfare.

Opportunity and Challenge

Tom Pickett, executive vice president, National Coal Association.

Coal today has both an opportunity and a challenge.

The opportunity is to serve the Nation by supplying an increasing share of energy to power its progress. In so doing, the coal industry's own position is improved. The opportunity, of course, is not reserved to coal alone. Our competitors, both domestic and foreign, are equally eager for new customers and for a larger share of the demand from old customers.

The challenge comes in two parts. The first is to the mining companies individually—to strive for better and more economical ways to produce, prepare and transport coal, with the view of

(*Continued on p. 124*)

GEORGE E. LOVE, chairman, National Coal Policy Conference, discusses its origin, aims and development; calls for industry-wide backing to ensure success.

Exporters Assess Outlook

COAL will continue to supply a large part of European Coal and Steel Community energy requirements, but its share of rising total needs will drop in the near future, according to **Dr. Ernesto Manuelli,** chairman of the board, Societa' Finanziaria Siderugica (Finsider), Rome, Italy. Addressing the 14th anniversary luncheon meeting of the Coal Exporters Association of the United States, Inc., Dr. Manuelli added:

Community estimates show that energy imports by participating countries should climb from the present annual 100 million tons of coal equivalent to 189 million tons in 1965 and to 303 million tons in 1975. "This means that imports of power should treble; at the same time, the share of coal needed to meet total energy requirements will fall from 60 to 40%.

"It is hard to say what part of total requirements will be met by nuclear power. However, a broad estimate shows that, beginning with 1962, imports of energy sources would be about 160-170 million tons coal equivalent per year; nuclear power should fill the balance.

"If energy requirements expand as foreseen, I personally believe correct the opinion of those who forecast imports of energy sources greater than estimated. In fact, in Europe the erection of nuclear plants is not going on at the high pace expected at the time estimates were made."

European coal will certainly become weaker competitively, although there will be no significant change in its consumption in the foreseeable future, Dr. Manuelli said. He also stressed:

1. "Europe cannot and does not want to, isolate itself economically by applying self-sufficiency policies, either generally or in the field of coal; in fact, its economy will continue to become more and more closely connected with the rest of the world, under a system of free competition.

2. "Italy's peculiar position justifies its tendency to meet coal requirements through countries outside the community."

Association Business

In a business session following the luncheon, **S. Pemberton Hutchinson,** executive vice president, General Coal Co., was elected for a 1-yr term as Class A director. **A. A. Meyer,** president, Saljoan Coal & Coke Corp., became a Class B director. The following Class B directors were reelected for 2-yr terms expiring in 1961:

W. H. Carpenter, president, Dexter-Carpenter Coal Co., Inc.

A. F. Kempe, president, Seneca Coal & Iron Corp.

Irving Sabsevitz, vice president, Foreston Coal Export Corp.

The association's slate of officers, reelected, includes:

Chairman of the board—**John S. Routh,** chairman of the board, Routh Coal Export Corp. Vice President—**D. K. Mackenzie,** vice president, Castner, Curran & Bullitt, Inc.

Treasurer and general counsel—**James W. Haley,** vice president, Jewell Ridge Coal Corp. and Jewell Ridge Coal Sales Co., Inc.

Executive secretary—**F. F. Estes,** Wash., D. C.

Asst. secretary-Asst. treasurer—**Mildred M. Loveless,** Wash., D. C.

Highlighting the business session, President Routh said the European coal situation during the past 9 mo has been "a most complex one" involving problems never confronted before.

"While we have not succeeded 100% in what we set out to do in completely eliminating the restrictions in effect on American coal, with the help of our State Department, we have been successful in limiting their applicability to the extent that American coal, other than to the Federal Republic of Germany, is moving free of import restrictions, and this, in the light of what has happened, represents a tremendous accomplishment."

F. F. Estes, executive secretary, emphasized that "U.S. coals must remain competitive on a Btu laid-down basis and must not be otherwise handicapped in the Western European market. In the offing, he noted, are increasing competition from Russia and Poland, as well as continuing threats of import restrictions, barter deals and state subsidies.

D. T. Bulkley, chairman, government relations committee, praised the State department for its full cooperation in helping the association prevent the spread of West Germany's import duty on coal to other ECSC countries. "By no means however, is the problem settled", he said. "We must continue to fight restrictions. U. S. coal should not be made the whipping boy for a situation which is primarily due to energy displacement by cheap oil."

M. F. Bergan, chairman, transportation committee, explained that the drop in 1958 coal exports, along with lessened domestic consumption, had caused serious demurrage accruals at the ports. However, he said, "we look forward hopefully to an improved situation by year's end, though there is still much to be worked out.

What NCA Committees Are Saying . . .

FOLLOWING are highlights of NCA reports presented by committee chairmen:

Land and Water Use—A new rash of state legislative actions are attempting to restrict and penalize coal mining operations, R. L. Ireland informed. But a successful battle against these efforts is being fought with the cooperation of the American Mining Congress. Under special attention are measures recently introduced by Congress for a survey of the extent and character of strip mining in the U.S.; a new draft of acid mine-drainage regulations proposed by ORSANCO; and the possibility of widening the scope of committee activities to include air pollution.

Education—To reflect purposes more accurately, the commitee's name has been changed from "Vocational Training and Education" to "Education", Roland C. Luther reported. Committee sentiment still favors giving top priority to the job of encouraging able young men to enroll in mining engineering curricula. An up-to-date filmstrip showing the coal mining engineer on the job is being considered. Industry volunteers will be asked to address high school groups on the subject of coal and careers in coal mining.

Engineering—The bulk of the past years' efforts have been devoted to extending and retaining the multi-million ton government market, according to C. R. Griffith. Definite signs of growth in this market are seen as more Air Force installations follow the trend toward central-plant systems. Activities are widening in scope to cover such general projects as aiding plant designers and equipment manufacturers, and providing engineering counsel to NCA staff projects.

Competitive Fuels—There will be no important legislation amending The Natural Gas Act at this session of Congress, D. W. Buchanan Jr. reported. NCA aided the cause of temporarily blocking imports of Canadian gas into midwestern markets. Revised applications by two pipeline companies have, however, now been approved and NCA is considering further appropriate actions. Due principally to coal opposition, the FPC has denied natural gas service to Virginia Electric Power Co.'s Possum Point plant and to Consolidated Edison Co. plants in N.Y.C. NCA efforts contributed much to bringing about mandatory federal controls on imports of residual oil. Effectiveness of these controls will be watched continually.

Economics and Statistics—Now that reliable distribution statistics are available, the committee will spend more time gathering market data on competitive fuels, Russell Harman said. Results so far show the proposed supplies-cost index would prove an impractical tool for management. Therefore, discontinuance of the contract on this project with BLS has been recommended. In its 5-yr forecasts started this year, the industry now joins its competitors in medium-range projection of demand.

Coal Car Supply—In terms of new vs retired units, there has been a net loss of 15,235 hopper cars in service during the 15 mos ending April 1, 1959, J. T. Berta said. Up to the week of May 16, however, the railroads have avoided a hopper car shortage. The supply outlook after the vacation period is generally good as a large number of cars are scheduled for delivery after the first half and the number of bad order cars has been reduced because of the heavy repair program.

Atomic Energy—K. A. Spencer reaffirmed that the committee's general philosophy is (1) to favor constructive research programs toward the advancement of technology in all forms of utilization, and (2) to oppose government subsidy of, and the crash approach to, atomic production of electricity. In its February, 1959 meeting with the Joint Comittee on Atomic Energy, NCA supported proposals for prototype reactors, but disagreed on further subsidies and on the alleged need for developing competitive nuclear power domestically during the next 10 to 30 yr.

Interstate and Foreign Commerce—During the past year legislation enacted included repeal of the 4c-per-ton transporation tax on coal and amendments to provisions of the Transportation Act of 1958 affecting competitive carrier matters. W. F. Schulten said legislation pending but not due for action this year deals with exemption from ICC regulation of certain bulk water carriers, congressional study of long-range transportation policies, user charges on waterways, carriers' rights to change or discontinue train and ferry service in interstate commerce, and a proposal to establish a department of transportation and communications with cabinet status. Noted was fact that eastern railroads have adopted a policy of establishing incentive, or agreed, rates for volume-tonnage utility customers.

Safety—The industry can be justly proud of its record last year which showed the lowest number of fatal accidents and non-fatal injuries in recorded history, S. A. Caperton declared. A new and revised "falls of roof, rib and face" accident prevention campaign, sponsored by the National Safety Council, will be announced shortly according to NCA's safety director who serves on the steering committee. Note also that the forthcoming National First-Aid and Mine-Rescue Contest at Buffalo, N.Y., October 5-7 will probably be the "best ever."

Taxes—Several years of concentrated effort have culminated in a completely revised definition of property, H. E. Lohmann advised. NCA will continue to work with the Internal Revenue Service to settle contractors' claims to depletion under "economic interest." These claims should have been laid to rest by the Supreme Court in the Parsons vs Smith decision April 6, 1959. Other items on the agenda include study of Treasury's proposal to redefine "income from mining" and a new problem of state taxes on net income from interstate commerce.

Research—Harry La Viers informed that Federal legislation setting up an independent coal research commission was nearing final stages. Both the Senate and House are due to pass companion bills soon. Because of overwhelming support by both houses, the President is expected to sign the bill in spite of a veto that probably will be recommended by the Department of the Interior.

Public Relations—A bolder, more comprehensive program has been started. H. V. Fritchman said it would be aimed at getting more favorable treatment for coal in Congress and the executive branch, as well as more favorable consideration from the general public. Important gains have already been made through a newspaper ad which refuted fallacious claims of New England senators seeking to undercut oil import restrictions. A program is now being prepared to fight the use of natural gas as a boiler fuel. Worth noting is the NCA sponsored special supplement on coal which appeared in the Sunday N.Y. Times, June 7. All new efforts will be carried on while the staff continues the fine public relations program it has been conducting.

Membership — Despite economic conditions in the industry, membership has more than held its own, G. E. Owen advised. Meetings with area subcommittees will be resumed when details of NCA's pending reorganization are available.

Herringbone's two pairs of Lang lay strands and one pair of regular lay strands provide the ideal combination of maximum flexibility with good stability.

Finer wires inside contribute to Herringbone's excellent drum-winding characteristics.

Heavier outside wires in each strand have greater resistance to abrasion.

"...and it has a much longer life"

GASKILL CONSTRUCTION COMPANY

The above quote is one of the things that Gaskill Construction Company says about the new Roebling Herringbone* Wire Rope. There are further quotes: ". . . We, after giving your Herringbone cable a great deal of use, find that it is far superior to any other cable and it is much more economical."

These are *user* statements about the newest design development in wire rope in many years. Herringbone is the regular lay and Lang lay wire rope. It is two-ropes-in-one rope, with the best features of each in combination. It has been used, with the same success quoted here, on a wide variety of machines as well as on tough hoisting jobs. Its potential is virtually unlimited wherever all-steel ropes are specified and on most installations where fiber core ropes are standard.

Your Roebling Distributor has full details on Herringbone, or contact Wire Rope Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey.

*Reg. App. For

ROEBLING

Branch Offices in Principal Cities
Subsidiary of The Colorado Fuel and Iron Corporation

(*Continued from p. 121*)

keeping delivered costs competitive and maintaining stability of supply. The industry has shown ingenuity and resourcefulness to meet this challenge in the past 10 yr . . . Continued improvement rests primarily on the shoulders of experienced management and skilled labor.

The second part of the challenge is to the industry collectively. We must tell fuel consumers, the government and the public generally that coal is essential to the Nation—and that we have nearly a trillion tons of it. We must make them aware that coal is modern, efficient, economical and plentiful . . . Only industry-wide effort can supply all the elements necessary to meet this challenge. . . .

Industry leaders are considering ways and means of achieving better coordination and greater concentration of endeavor. Whatever may be done in this respect, the necessity for industry-wide participation in a sound program will continue.

Federal Coal

Capt. Phillip D. Chubb, Supply Corps, U. S. Navy, Commanding Officer, Navy Fuel Supply Office, Wash., D. C.

We recognize the importance of your great industry in producing energy for national defense and we are grateful to the National Coal Association for its assistance in helping solve many coal problems.

We think of ourselves at the Fuel Supply Office as a big customer and, we hope, a good customer. Last year we bought 4 million tons of coal, involving 400 contracts for more than 200 different military installations.

About 100% of the coal is bought using sealed bids under formal advertising. A formula for evaluating coal bids has been in use for about 8 yr, with few, if any, objections to its elements or application. The successful use of this formula is in no small part due to the excellent cooperation we have enjoyed with the coal industry and its trade associations.

The development of our General Provisions for Coal Contract was another example of the coal industry's assistance and spirit of cooperation. . . . One point I would like to make clear. If you receive an invitation to bid on coal and specifications appear out of line, and you feel for the benefit of the government and for you as a citizen, they should be changed, please tell us. . . . Also, watch your analytical reports very closely. If one or more appear out of line, challenge it. . . . We invite you to make suggestions and recommendations that will be mutually beneficial to the government and your industry. . . . We want to be a good customer."

ROBERT E. GIBBONS, vice president, Incorporated Investors, Inc., and moderator, competitive fuels panel.

National Fuels Policy

William R. Connole, vice chairman, Federal Power Commission.

Everybody in the energy business should have the same goal—the development of a meaningful, practical, and equitable energy policy for the best use of the Nation's fuels.

To achieve this end, the coal industry should take a giant step forward to promote the creation of an energy study board. The coal industry, UMWA, equipment manufacturers, coal-carrying railroads and electric utilities have already shown great foresight and courage in establishing the National Coal Policy Conference. This is an important jumping-off-point from which greater progress can be made.

The energy study ought to be wide enough to cover all forms of energy. The study should first decide where our present policy is taking us. The study should be made by an objective group dominated by government but using facilities of industry and independent research groups. The study should employ public hearings across the Nation as well as task force studies. The study should have as its aim, legislation.

Everything done by energy-producing and distributing industries, consumers and government contributes to a national energy policy. But qualitative judgment is needed on whether the policy being formed is best for all segments of the economy for as many years in the future as it is possible reasonably to plan for.

When we think that our energy resources are being consumed at such an incredible rate that, for example, all the fossil fuel consumed in the history of the world up to the year 1900 would last only 5 yr at today's rate of consumption, we know how important this whole subject is to all countries and peoples of the world.

RAYMOND E. SALVATI: "We must continue to fight off competition and develop each market to the utmost."

The Competitive Picture

Bituminous Coal—The Next Five Years, Raymond E. Salvati, president, Island Creek Coal Co.

Production of bituminous coal is expected to reach 500 million tons in 1963, but the industry currently is suffering from restrictions and unfair competition which hampers it severely. Heavy imports of residual oil and widespread industrial use of natural gas are two conditions which should be corrected in the national interest.

The dumping of natural gas in the industrial boiler fuel market squanders an important natural resource. It injures both coal and gas in their natural markets, the ones each is best fitted to serve. The coal industry must work for government policy to prohibit the reckless waste of natural gas in industrial markets —a practice which usually results in higher gas prices for the household consumer, and eventually less supplies for domestic use.

Imports of residual fuel oil—a heavy, gummy fuel which is not used in house heating—have hit hard at coal's markets along the East Coast. President Eisenhower's recent restrictions on imports of this fuel only reduce shipments to the 1957 rate, when the tide of residual oil had already inflicted severe damage on the coal industry.

Coal has a sound future. Experts in many fields agree that consumption of coal is sure to increase, not only in the next 5 yr, but for decades beyond that. Coal men, however, must continue to fight off competition and develop each market to the utmost.

Natural Gas and Coal—W. M. Elmer, president, Texas Gas Transmission Corp.

A very bitter feeling has developed between major portions of the coal and gas industries, due to the lack of under-

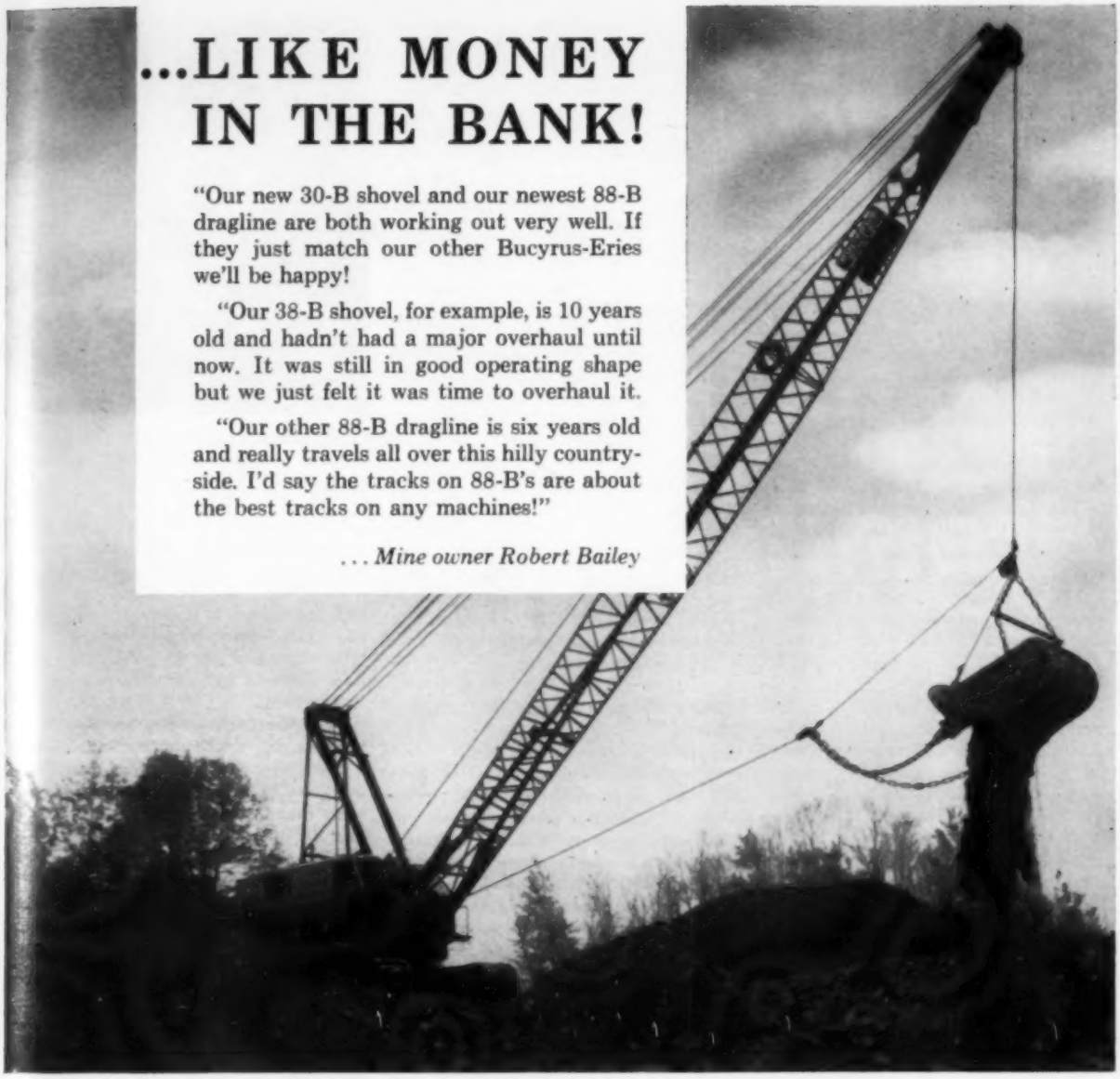
...LIKE MONEY IN THE BANK!

"Our new 30-B shovel and our newest 88-B dragline are both working out very well. If they just match our other Bucyrus-Eries we'll be happy!

"Our 38-B shovel, for example, is 10 years old and hadn't had a major overhaul until now. It was still in good operating shape but we just felt it was time to overhaul it.

"Our other 88-B dragline is six years old and really travels all over this hilly countryside. I'd say the tracks on 88-B's are about the best tracks on any machines!"

... Mine owner Robert Bailey



Robert Bailey operates three pits high up in the rolling hills around Gorton, Pa., uses Bucyrus-Erie for both stripping and loading out coal.

Why not enjoy Bucyrus-Erie top performance yourself? Your distributor will be happy to help you analyze your present equipment, show you how a new Bucyrus-Erie can help make your operations more profitable. Call him today, or write Bucyrus-Erie Company, South Milwaukee, Wisconsin, Dept. 39E.

BUCYRUS ERIE®

BUILDS BETTER EQUIPMENT

standing of their respective problems.

One source of misunderstanding involves misconceptions about reserves. It is unrealistic propaganda to assert that the 22-yr life index for proved natural gas reserves represents the total gas available to the public. Unanticipated reserves have opened in the last 10 yr; similarly, technology will open new reserves in the next 10 yr. There is, for example, a tremendous potential in deeper fields in the U. S., in offshore wells, and in Canada, Alaska and New Mexico.

Also, transportation of liquefied natural gas is going to work. It would be possible today to ship natural gas from Venezuela and sell it at a competitive price in New England if it would be used immediately without storage.

More misunderstanding arises over gas sales to the industrial market. There is justification now for these sales, although price trends indicate natural gas will price itself out of the steam market within a few years.

FPC regulations, supported by the courts, have imposed a rate structure on the gas industry which make off-season or interruptible sales imperative. FPC's job is to see that natural gas gets to the most people at the lowest cost. Off-season sales allow a greater spread of transmission costs and thus lower prices to residential consumers. If industrial sales were stopped, the fuel bill of home consumers would be raised $500 million a year.

Coal and gas should work together in solving mutual problems instead of being at each other's throat. The two industries, for example, should cooperate in studying gasification of coal to supplement natural gas supplies.

The Oil Outlook for the Next Five Years—John J. Scott, general counsel, Socony Mobil Oil Co., Inc.

Demand for oil will grow at just about the same annual rate as the total demand for energy, around 3%. This growth rate is substantial but somewhat slower than during the past 30 yr when demand for oil grew at about twice the rate of total energy demand.

The demand for gas will grow somewhat faster than the total energy growth, about 5½% a year. Again, this represents a slower rate of growth than gas has enjoyed in the past, especially during the past decade, when its growth was more than 8% a year.

We believe the decline in coal tonnage consumed each year in the country is ending. Coal's share of the total market will continue to decline slightly, but that coal consumption will grow by about 1.4% a year, against an annual loss of 2.9% during the past decade.

We don't see a measurable change in the position of hydroelectric power during the next 5 yr, nor do we think a significant portion of the Nation's power will come from nuclear power by 1963.

Prospects for meeting growth in oil demand from domestic and international production are generally healthy although unpredictable government interference could alter the picture. Domestically, for example, it is impossible as yet to assess the full effects of restrictions on imports of residual. If the flow of imports rises enough, the government might invoke its power of price "surveillance". More than any other aspect of the import restrictions, many of us view with alarm this potential power to control prices. If the power is used, it could bring long-range damage to oil and coal which would far outweigh gains which import restrictions yield for the coal industry.

The Future of Atomic Power—H. C. Anderson, Atomic Products Div., General Electric Co.

In the late 1960's, there will be an economic demand for nuclear power plants in the higher fuel cost locations in this country. But the effect of this demand on the coal industry in the next decade will be negligible.

In the next 10 yr, cumulative sales of electric energy will total about 10 trillion kwhr, of which about 70 to 75% will be generated in coal-burning plants, while the best estimates show that about ½ to 1% might be generated by atomic power.

By 1975, nuclear power will begin to make an impression in the total domestic market for steam power generation, roughly 10% of total installed electric capacity. Eighty per cent of the Nation's electricity will still be generated by conventional plants.

This 80% will be predominantly coal-fired, since by that time (1975) it is expected that domestic gas and oil production will be used chiefly for applications, such as transportation, requiring the more convenient forms of fuel, and in the petrochemical industry.

The coal fuel industry, in going from 70% of today's requirements to 80% of 1975's requirements, will increase in size about four times. During the same period, the atomic fuel industry will grow to be about 40 times its present size, at least as measured by total installed kilowatts, but it will still be only about one-eighth the size of the coal fuel industry.

BCI Reports

Carroll F. Hardy, managing director, Bituminous Coal Institute.

Successful marketing of any product depends on the product-image—what the consumer sees in his mind's eye when he thinks of it . . . BCI is presenting a product-image of a modern plant. The plant shows no coal or ash in sight; it is functional, colorful and clean. It is

CARROLL F. HARDY: "BCI is presenting a product-image of a modern coal-burning plant."

not only a coal-burning plant; but through BCI publicity it becomes a coal-selling plant.

BCI works on the consumer level, with management, consulting engineers and plant operating personnel. It has three objectives: get them on coal, keep them on coal, and sell them on coming back to coal. . . .

The short-term results of the BCI program are: 5,600 projects initiated in 2½ yr, of which 1,400 were closed to coal, and 1,200 closed—temporarily—to other fuels. We say temporarily because many of these plants will be prime targets for coal later. There are some 3,000 projects pending decision; some may never be decided, but they are not forgotten . . .

It is estimated that some 120 million tons of coal are sold in BCI's primary target area—commercial, industrial and institutional plants, both on and off track. The potential for coal, however, is much greater—about 300 million tons including 120 and 60 million equivalent-tons, respectively, of gas and oil use in this market.

BCI has contracted directly plants in the field consuming 40 million tons or tons equivalent. The score in this highly competitive market is nearly 5 to 1 in favor of coal; that is, the BCI effort gained or retained 15.2 million tons, as against a loss of only 3.8 million tons . . .

BCI has produced concrete results to justify its existence. It has set up a pattern for successful coal promotion. Here is an organization that works—the only need is for more of the same—more industry support in money and manpower, more cooperative action from coal men on every level, more individual efforts to win projects for coal, more interest in the future of coal as well as in immediate tonnage. BCI's pentagon is open on all five sides to everyone who wants to help in the campaign to make coal the No. 1 fuel now and for the future.

He wastes no time!

He pinpoints faults with an O-B Locator!

When a fault hits his trailing cable, he wastes no time. He pulls the plug and goes for his O-B Cable Fault Locator.

It takes him only a minute to clip two leads to the power conductors, two to the small six-volt battery—and he's ready for testing. Testing is simple too—a slow walk back along the cable with earphones and slim transistor receiver. When he hears a change in signal he's found the short or open and can make repairs.

If you've been wasting too much time tracking down hidden faults, you could use an O-B Locator, too. It's pocket size, weighs only four pounds, costs less than any cable you'll use it on. Send for Booklet K-423 for complete information.

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Foremen's Forum

CONFERENCES among men already holding responsible positions help in developing new insights and in sharpening the effectiveness of executive performance.

The Importance of Training for Leadership

The Fund for Adult Education advocates continuing education which will produce dedicated, intelligent leaders for the American Society.

EDUCATION for adults, particularly the kind of education that develops leadership, is the theme of a booklet entitled "The Great Awakening," by C. Scott Fletcher, president of the Fund for Adult Education, which was established in 1951 by the Ford Foundation. An event beyond the control of the American people, the launching of Sputnik I, has served to awaken us to a concern for that which we can control—the deliberate and systematic development through education of human beings who are able to use freedom responsibly, Mr. Fletcher writes. We must deliberately cultivate excellence and make sure that excellence is used to benefit all. This is education for leadership.

In recent years, several analyses of American society have been sharply critical of the organization of this society and its leadership, the author says.

One of these is a book entitled, "The Organization Man," by William Whyte Jr., in which "organization men" are classified as those of our middle class who have left home spiritually as well as physically, to take the vows of organization life, and it is they who are the mind and soul of our great self-perpetuating institutions. The author of the book, Mr. Fletcher points out, is concerned about the fact that organization men lack individuality, are rootless, tend to conform both within and without the organization, and instead of fighting the organization, they give in to it.

Mr. Fletcher takes the position that organizations and "organization men" are necessary for freedom. In the future our educational institutions and our organizations must cooperate to educate leaders—"organization men"—who have both individuality and social responsi-

AWARDS of $1,000 each for the best articles or speeches on public leadership have recently been established by the Fund for Adult Education. The awards, to be given in each of the years 1959 and 1960, are designed to generate the best thinking on the nature of public leadership and on ways in which more adequate education can be provided to help prepare American leadership on every level of social, economic and political organization to serve the general welfare.

For purposes of the awards, the term leadership encompasses the whole range of positions in which executive decisions and executive actions have public consequences. It would include elected and appointed officials in federal, state and municipal governments, corporation executives, members of boards of directors of national organizations, school board members, labor leaders, foundation officials, leaders of political parties, and so on. On the other hand, the leadership in the award context excludes from consideration leadership whose force is primarily intellectual, spiritual or artistic.

Full information may be obtained by writing C. Scott Fletcher, president, The Fund for Adult Education, 200 Bloomingdale Rd., White Plains, N. Y.

Yieldable Arch can be installed as the drift is being driven

These workmen illustrate another special advantage of Bethlehem's yieldable mine roof support: they're installing Yieldable Arch sets right next to the breast of the drift. That means the overburden is brought under immediate permanent control, without the time and expense of temporary roof support.

And we do mean *control*, for as soon as the surrounding forces bear down too hard, the Yieldable Arch will give a little instead of collapsing. This allows the overburden to settle gradually until it forms a natural pressure arch around the mine opening.

The Yieldable Arch works on a sliding joint principle, with friction the determining factor. Nestable segments of U-shaped rolled steel are overlapped at the ends, and these joints are secured with heavy U-bolt clamps which are drawn up tightly enough to hold fast under normal loads. Excessive pressure, however, overcomes the friction in the joint, causing the arch to yield. The load is thus relieved and the structural integrity of the arch is maintained.

Horizontal braces or struts tie one arch set to the succeeding one to provide lateral stability to the structure. Blocking and packing between the lagging and roof are recommended to distribute loads evenly.

Bethlehem engineers have acquired considerable experience in the use, installation and maintenance of Yieldable Arches, and would be glad to apply their experience to your mine-roof problems. A visit to your workings would, of course, be helpful and we would welcome the opportunity whenever it is convenient for you.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

bility, who do not merely "respond" to a situation in terms of "security", but can work creatively to make the organization responsive to the values of our free society.

Another harsh critic of American leadership is C. Wright Mills, in his book entitled, "The Power Elite," Mr. Fletcher says. Mr. Mills' thesis is that since World War II a combination of circumstances has led to the emergence of a "power elite" which consists of top-ranking military leaders, politicians and corporation chiefs. One reviewer of the book said that Author Mills see U. S. leaders as morally bankrupt and the American people as having almost nothing to do with deciding their political fate.

"My position," Mr. Fletcher replies, "is that power and the effective organization of power are necessary for the exercise of freedom. The preservation of freedom in the United States and elsewhere, and its extension to peoples who are not free, require the intelligent, humane and wise use of power."

In the United States we can no longer count on the automatic or accidental emergence of dedicated, courageous, imaginative and wise leaders.

We must now educate for them purposefully and by design. That we have not done so previously should not be surprising. Our educational system was not planned with world leadership in mind, Mr. Fletcher continues. It grew haphazardly, preoccupied with such concerns as how to deal with waves of migration, how to fit people for new occupational tasks, and how to deal with changed social conditions. Thus our neglect of the large and primary goal of education is understandable, but it is no longer tolerable—now that the future of the United States and of all free societies is clearly at stake.

The primary goal of education in a free society is to prepare people to make wise decisions. There are, to be sure, other goals to be achieved to enable this to happen. But ultimately, the goal is education in action—namely, knowledge and thought translated into wise decisions.

The education that fosters the ability to make wise decisions should be as long as life itself and should take place in many situations. Formal schooling should be the preparation for self-education continuing throughout mature life.

Although not enough in itself, we can afford only the best schooling of our young people, from the primary through the higher levels. We must attract and hold superior teachers. We must pay them well—in money and, equally important, in honor and respect.

COLLEGES and companies are increasingly turning to cooperative "retreat" training sessions for professional enrichment of leaders.

Curricula must be stripped of nonessentials, and must be made demanding and stimulating to elicit the best that is within the pupils. Not adjustment to the present but mastery of the future, Mr. Fletcher says, should be the objective of our schooling.

Turning to continuing schooling, or adult education, the author expresses concern that so many Americans equate education with formal schooling.

Many think that one can leave off systematic learning just when he begins to assume mature responsibilities. Many regard adult education as the mark of a deficient schooling rather than the essence of education, which it properly is. Only mature people have the experience to understand the most important issues of life. This has always been so, even in times of slow change. Its truth has particular relevance in modern time, with its ever-quickening tempo of change.

In recognition of these factors, the directors of the Fund for Adult Education have outlined a program for the promotion of continuing education which will depend for its success on the cooperation of our organizations and educational institutions, on all levels.

The program should consist of two parts—first, courses of study and discussion of vital issues; second, the deliberate cultivation of leadership in voluntary affairs. In the first of these, many colleges and universities and companies are cooperatively offering seminars and courses of varying length for today's decision makers who now are wrestling with crucial problems. Other courses have been developed for those who show potentialities for leadership. In fact, one of the best ways of identifying leaders of the future is to discover those who are concerned with continuing their education.

Many studies have indicated, Mr. Fletcher notes, that the years of the thirties and forties are a period in which men and women are particularly receptive to continuing their education in order to develp their capacities for leadership.

The second part of the program, previously mentioned, should be participation in the affairs of the community and of associations. Study and reflection are essential, but by themselves they are not enough. They need to be supplemented by experience in leadership. Opportunities for such experience are all around us. They exist in the voluntary affairs of the community. For example, it is estimated that in the United States there are nearly 200,000 board members of public elementary and secondary schools, 6,500 board members of junior colleges, 20,000 trustees of colleges and universities and 60,000 trustees of libraries.

Organizations of all kinds, particularly businesses, should encourage their members to take part in voluntary community activities. These are frequently the training grounds for larger civic, national and international responsibilities later. Another rich field of opportunities for experience is in the affairs of national associations. Promising young people should be given opportunities to help lead in the conduct of association affairs.

As a clincher, Mr. Fletcher reminds us that in the creative period of the American nation—when new institutions were invented and established—we had a marriage of thought and action. Men of action were intellectuals. Men of thought were concerned with the consequences of ideas in action. The realm of the intellect and the spirit was an honored realm.

The future will not be lost or won by arms alone or perhaps even primarily. It will be lost or won in the realm of ideas, and we must have leaders who are equally at home with action and with ideas.

69 yards at a crack! This Autocar AP25 planetary gear drive tractor with bottom dump trailer hauls 69 cubic yards of coal per trip from pit to tipple.

Autocar AP25T . . . born to take a big load off any operator's mind

This Autocar is BIG . . . capable of BIG performance and BIG production. It's a rugged, reliable giant that makes short work of tough jobs. With power to spare at the wheels, it clambers up steep grades and over rough terrain at a profit-making pace . . . takes the *shortest* route to destination, not necessarily the easiest.

The AP25, like other Autocars, is a specialized production tool, especially designed and built to work harder and faster for you at less cost . . . to move more tonnage per shift and to stay out of the repair shop, getting extra production and cutting your costs at the same time.

For ruggedness, maneuverability, power, you can't beat Autocar construction, design, quality. Where a job gets tough enough or big enough to worry about—that's the time to look at an Autocar . . . "World's Finest." Settle for nothing less!

Autocar
"World's Finest"

Division of
The White Motor Company
Exton, Pa.

Operating Ideas

Fuel Oil Selection Chart

Type of Engine Application	Ambient Air Temperature	Distillation: 90% Boiling or Point (Max.)	Distillation: Final Boiling Point (Max.)	Cetane Number (Min.)	Sulfur Content (Max.)
Wide variation in load and speed, considerable idling.	Above −20 F	550 F	575 F	45	0.25%
	Above 0 F	575 F	625 F	45	0.50%
	Above +40 F	575 F	625 F	45	0.50%
	Above +80 F	625 F	675 F	40	0.50%
Intermediate load and speed, minimum idling.	Above −20 F	550 F	575 F	45	0.25%
	Above 0 F	575 F	625 F	45	0.50%
	Above +40 F	625 F	675 F	40	0.50%
	Above +80 F	625 F	675 F	40	0.50%
Heavy load and high speed, minimum idling.	Above −20 F	575 F	625 F	45	0.50%
	Above 0 F	625 F	675 F	40	0.50%
	Above +40 F	625 F	675 F	40	0.50%
	Above +80 F	675 F	725 F	40	1.00%

LESS possibility of harmful deposits and corrosion in the engine can be expected from these fuels.

What Diesel Fuel to Use?

THE OLD SAYING "Diesel engines will burn anything" is still as true today as when it was first coined. But it was not long before the inventor, Dr. Rudolph Diesel himself realized that fuel characteristics are important considerations for the digestive tract of a diesel engine.

The types of fuels available for use in diesels vary from highly volatile jet fuels and kerosene to the heavier furnace oils. All high-rpm diesel engines are capable of burning a wide range of fuels within these two extremes. How well a diesel engine can operate with different types of fuel is another matter. Successful operation will vary from one fuel to another depending on a number of factors, including engine operating conditions and fuel characteristics.

Since diesel engines depend upon heat for combustion, the temperature of the compressed air in the combustion chamber at the point of fuel injection is very important. Only in rare instances are high-rpm diesel engines continuously operated at, or even near their rated maximum speed and load capabilities. These variations in speed and load result in a variation in the temperature of the combustion chamber of the engine.

Besides speed and load, the temperature of the outside air used in the engine has an effect upon compression temperatures. For example, an engine operating at 20 deg below zero will have lower compression temperatures than one operating when the temperature is 100 deg.

Adapted from *Fuel Oil and High-Rpm Diesel Engines*, available from Detroit Diesel Engine Div., General Motors Corp., Detroit 28, Mich.

Kerosene and ID fuels, commonly known as high-grade fuels, seldom contribute to the formation of harmful engine deposits and corrosion. Refining removes the impurities but also lowers the heat value. This slight disadvantage is usually more than offset by lower maintenance cost.

Jet fuels are low in Btu content and lubrication quality. As a result, some diesel fuel systems must undergo major modifications to be able to use this type of fuel. Two-cycle engines with unit injector fuel systems do not need major change.

Low grade fuels are more apt to cause engine owners greater concern because they have progressively higher boiling points and contain more impurities. Cetane rating (a measure of the delay time between injection and ignition of fuel), boiling range and sulphur content are three important properties to know about diesel fuel.

Cetane Rating

Rapidly ignited fuels have high cetane ratings. Slowly ignited fuels have low cetane ratings. A fuel with better ignition quality would assist combustion more than a lower cetane fuel when engine compression temperatures are cooler. The lower the ambient temperature the greater the need for a fuel that will ignite rapidly.

Boiling Range

Fuel can be completely burned only in vaporized form. Because of this, the boiling range of fuel oil should be low enough to permit complete vaporization at the existing engine temperatures. For engines operating at reduced speed and loads or in cold weather, lower boiling point fuels will give more satisfactory performance. Fuel that cannot be completely vaporized and burned will accumulate and form sludge and harmful deposits in the engine.

Sulphur Content

Sulphur content should be as low as possible. Limited quantities can be tolerated but there is a direct relationship between the quantity of sulphur in the fuel and the corrosion and deposit formation within the engine. Tests show that increasing sulphur content from 0.25% to 1.25% increased deposits and wear 135%.

Other properties and impurities of fuel oil to be considered are:

Viscosity—Fuel should be able to flow freely at the lowest temperature expected.

Pour point—For cold weather operation, the pour point should be specified 10 F below the ambient temperature at which the engine is to be operated, except where oil heating facilities are provided.

Water—Corrosion and wear in fuel injection systems and formation of harmful ingredients in the lubricant are results of water and contaminants.

Ash—Ash usually contains metallic oxide and sand which result in abrasive action and therefore should be kept to a minimum.

Carbon residue—Also should be kept to a minimum to prevent overheating of pistons with accompanying ring and cylinder lining failure, or formation of hard, glossy lacquer.

Cloud point—Measures temperature at which wax crystals start to separate from the fuel. This point should be below the lowest temperature encountered to prevent clogging of fuel filters.

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When you splice and reinsulate with Uskorona® and re-jacket with "D.R." splicing compound, you renew the life of the cable. *The entire splice will last as long as the cable.*

These entirely reliable tapes are:

- Extra-tight gripping, plus high in tensile strength.
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Uskorona exceeds A.S.T.M. specifications and can handle a wide range of electrical and general purpose jobs in mines. A complete line of mine tapes is available.

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US RUBBER USKORONA SPLICING TAPE

ABOVE GROUND. When spliced with Uskorona and "D.R." tapes, cables become perfect again. These splices restore the mechanical and dielectric quality of the cable, resist severe abrasion and exposure to moisture.

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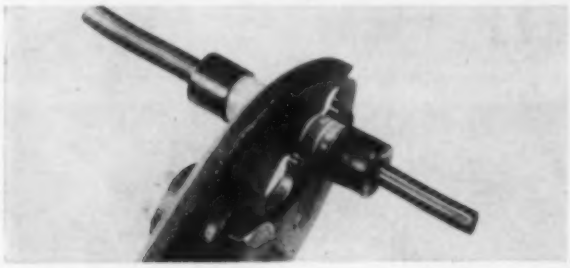
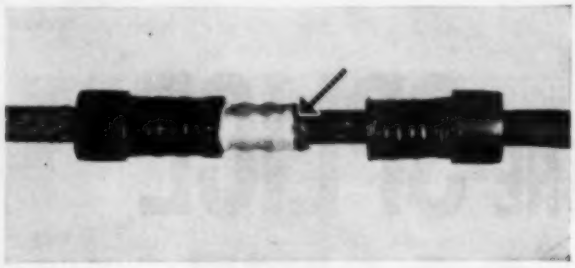
Operating Ideas (Continued)



STANDARD TOOL crimps pre-insulated connector. Taping of splice is eliminated, thus reducing time required.



CUTAWAY VIEW of splice after salt spray chamber exposure shows no corrosion. Arrow shows oxide inhibitor.

Insulated Connector Resists Corrosion

E. S. RAILA, Supervisor, Design Engineering Section, Utility-Industrial Div., Burndy Corp., Norwalk, Conn.

A pre-insulated compression connector called an "Insulink" reduces the problem of connecting services to a simple, tool-controlled operation that one man can perform easily. The corrosion-resistant connector can splice aluminum and copper cables ranging from No. 10 through 1/0 and ACSR from No. 6 through No. 2.

Designers had to develop a coating for the connector which could:

1. Transmit the pressure of the compression tool to the sleeve without being pierced.
2. Electrically insulate the completed connection.
3. Protect the connection against water and weather. Additionally, the connector had to be installed with standard tools and compare with present splices in cost. Finally, a way had to be found to hold both cable ends in the connector while the lineman crimps it.

The connector consists of an aluminum sleeve, a nylon jacket and a polyethylene cap on each end. After testing a number of plastics, engineers found that nylon, with carbon black added to improve resistance to weathering, had the best combination of properties.

Splice sections were immersed in 5% (by weight) salt solution and subjected to 1,500 V for 1 min. After immersion for 168 hr, no leakage was detected.

Repeated current cycling showed the electrical stability of a No. 2 stranded aluminum to No. 4 stranded copper service entrance splice. A 170-amp current was passed through the splice for 1½ hr, raising conductor temperature to 125 F, after which current was turned off for an hour. After 114 cycles, relative conductivity of the splice was unchanged.

After 500 hr in a concentrated salt spray, samples showed no erosion of connector or conductor due to galvanic action.

Adapted from *Electrical World*, another McGraw-Hill publication.

New Bin-Level Indicator

A DIFFERENT approach to the design of bin-level indicators is said to offer promising results for the remote indication of the coal level in a bin, according to an article in *Bergbautechnik* and summarized in *Iron & Coal Trades Review*, May 15, 1959. Based on the principle of changing capacity of a condenser as it becomes covered by coal, the indicator is reported to have been in service for over a year in an East German briquetting plant. It was installed in a bin holding very fine coal below 0.04 in.

The device is made up of a rail fixed on insulators a certain distance from the inside of the bin wall. Electrical connections are made through the side of the bin to the rail. The capacity of the condenser, formed by the rail and the bin wall, changes as the level of coal in the bin changes. The rail electrode is connected to the grid circuit of an electronic amplifier and the change in capacity of the tuned circuit is recorded as changes take place in the bin level.

Level indicator for bunkers
1—Measuring Electrode
2—Supporting Insulators
3—Bunker Wall
4—Electrical Connections
5—Terminal Box

Computer Solves Air Problems

ELECTRONIC BRAINS are solving complex ventilation-network problems in Belgium. With the aid of a computer, a network with 63 closed circuits was calculated in only a few hours. Without the computer, solution of the problem would have required some years.

Solving ventilation-network problems by successive approximations was applied to solve a practical problem at the Winterslag colliery in Belgium, according to *Iron & Coal Trades Review*, May 15, 1959. Using this method, it took three days to calculate a network of 10 closed subcircuits. And 15 closed circuits is thought to be the practical limit for the application of this method. But electronic computers offered a way to overcome this handicap and the colliery accordingly used a computer to calculate a network with 63 closed circuits. Data were fed into the computer in the form of punched cards and the answers were supplied in the same form. They could have been supplied in tabular form.

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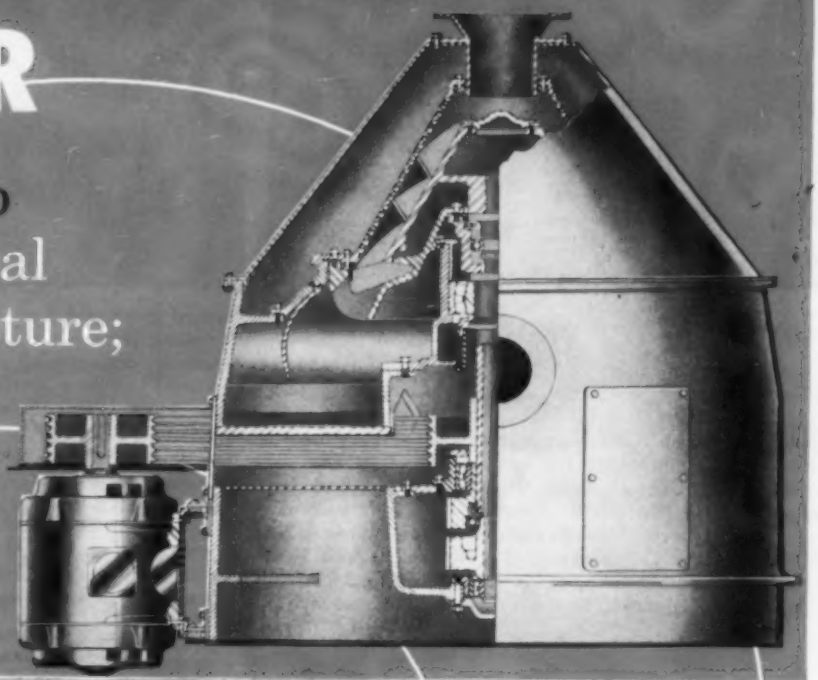

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Brochure No. EB-36 giving complete details available upon request.

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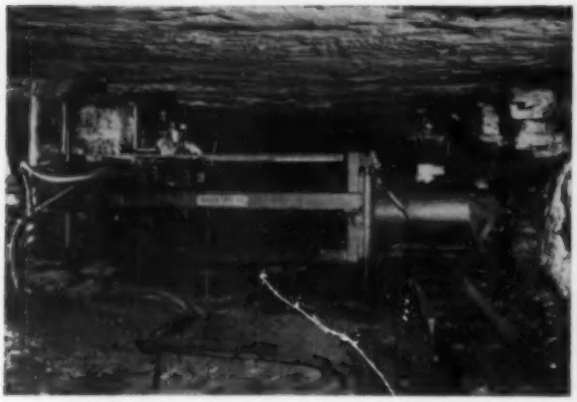
Equipment Developments



New Underground Augers

For a variety of underground drilling purposes, auger drills for both bituminous and antracite mines are now being marketed by the Salem Tool Co., Salem, Ohio. One line of drills (photo left), which handle augers from 24 to 44 in in diameter and 5 ft in length, will produce up to 40 tons per man-shift in bituminous seams, says the company. The drill and its separate power unit, connected with 50-ft hydraulic hoses, are self-moving on skids and jacks. The power unit has two 50-hp AC or DC motors. Unit measurements with 34-in augers are 7 ft 10 in in width, 48 in in height, and 11 ft 3 in in length. The cutting head revolves at 33.75 rpm with a forward speed of 6 fpm. By reusing the first string of augers as drilling proceeds the machine can cut as far as 100 ft.

Another underground drill (seen at right in anthracite workings) can drive ventilation holes, burn holes and escapeways at angles from 15 deg below horizontal to 90 deg above. It bites 100-ft holes 8 to 24 in in diameter in one-third the time of conventional methods, according to Salem. It will back-ream to a 48 in dia above or below. Powered by a separate unit with a 60-hp motor, AC or DC, the drill is 68 in wide, 48 in high, and 8 ft long. When the drilling mast is vertical it is just 7 ft 6 in high. Anthracite is handled without difficulty and both units, mounted on skids and jacks, can traverse slopes as steep as 18 deg without help.

Air-Powered Feeder

This new-type pneumatic feeder, from Joy Mfg. Co., Pittsburgh 22, uses air power to feed shuttle-car loads to conveyor belts. It is designed for low-seam mines where conventional bulky feeders are impractical, states the firm. The machine has two 32-ft long inflatable neoprene bags and a 36-in wide gooseneck chain conveyor running between them to elevate coal to loading height. Loaded shuttle cars are run up on the uninflated bags and their loads dumped. Backing away after unloading, the car operator pulls a cord starting the chain conveyor and tripping a small 3-hp fan that starts to inflate the bags. These bags inflate from the outside toward the center moving the coal inward and onto the conveyor. When the coal has been removed the fan reverses, sucking the air out. By means of a timer that adjusts cycles to individual loading conditions the widest shuttle car can unload at maximum rate with shorter trips and fewer delays, declares Joy.

New Scraper

A new tractor-drawn crawler scraper with increased capacity, greater flotation and more durable construction has been announced by Caterpillar Tractor Co., Peroria, Ill. The unit, No. 463 Series C, can be used with either D8 or D9 tractors without modifications. Struck capacity has been increased from the previous model's 18 cu yd to 22. Increased flotation has been accomplished by use of wide-base tubeless tires. Numerous structural improvements, declares Caterpillar, match the scraper's durability to its increased capacity. Two new support ribs strengthen the weld between bowl sides and cutting edge supports. New internal braces have been added between the back and bottom of the bowl. By raising the apron pivots 5½ in, opening height has been upped and closing action improved, adds the company.

Announcing 3 NEW CARMET Mine-Tested Cutter Bits

Here's a trio of precision-made cutter bits, proven in operation to give long service under tough mining conditions. Your Carmet distributor carries them, and cutter bits for every mining operation, in stock. Check with him now.

Carmet JC Style Colmol and Boring Bit

Note the collar support that prevents bit block from splitting. Shank is forged from high-alloy heat-treated steel. Tough, hard, wear-resistant carbide tip is double-bonded by mechanical cap. Long operating life under all conditions.

Carmet JR Style Cylindrical Bit

Another new outstanding Carmet bit for use on all cutting machines and continuous miners. Tip is embossed in high alloy heat-treated steel.

Carmet GV Style Bit for Joy Cutter Chain

Designed with husky bull-neck for use on Joy GV-6111 cutter chain. Style GVR has drilled carbide insert brazed into shank for maximum support. GV series available with double-bonded insert brazed to milled shank.

New Carmet Mining Tool Catalog Now Available From Your Carmet Distributor

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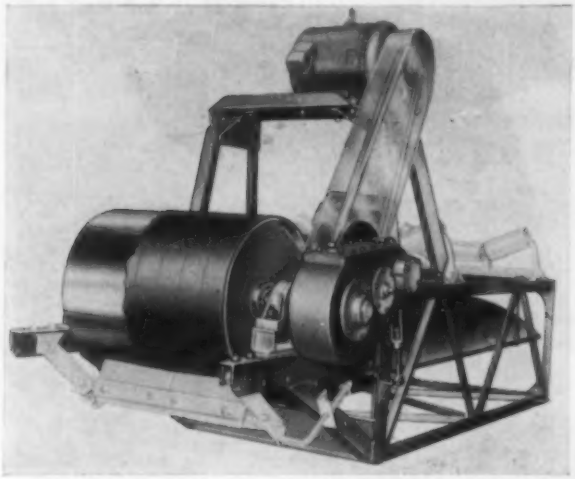
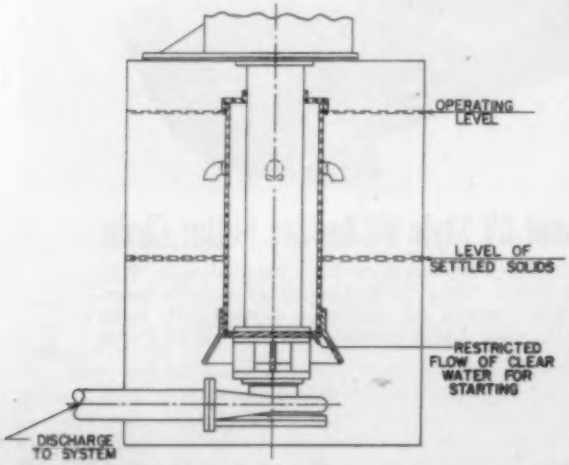


Belt Conveyor Drives

Better balance, greater accessibility, quieter operation and factory assembly are some features cited by Barber-Greene, Aurora, Ill., for its new series of standardized Torque-Arm belt-conveyor drives. Available in a variety of belt widths and horsepower ranges, these complete drive ends include head pulley, headshaft, bearings, reducers, V-belts, sheaves, motor support, V-belt guard and frame. The drives are simpler and require less maintenance than other types of belt-conveyor drives, states the company. They are completely assembled, aligned, adjusted and tested before leaving the factory. An important innovation is placement of the V-belts between the head pulley and the reducer instead of outside the reducer, resulting in better balance, better walkway clearance, decreased load on headshaft bearings and less twist on truss from V-belt tension, according to Barber-Greene.



Non-Plugging Pumps

Ability to handle solids without plugging is a major feature of the Type 400-V balanced two-volute vertical pump, offered by the Goyne Pump Co., Ashland, Pa. As shown in the accompanying sketch, the pump inlet is protected by a skirt extending out far enough so that, taking advantage of the angle of repose, the material does not fill up to the inlet. The design also provides for a restricted flow of clear water for starting, and, Goyne representatives note, permits the flow of liquid and solids to be established and continued in spite of solids that may have settled in the line. There are no underwater bearings and no packing box. The same principle of inlet protection also may be employed with a horizontal pump as well, and with the vertical pump outside the sump or tank as well as in.

Portable Power

A low-cost silicon mine power supply only 30 in high is new from General Electric Co., Schenectady 5, N. Y. Consisting of a rectifier car and transformer car, the portable equipment is 28% lower in height than comparable mercury-arc rectifiers, making it particularly valuable for low-seam mines, reports the firm. These "Lo-Boy" units are available in ratings from 300 to 750 kw, 275 to 550 V DC, and are designed to withstand 150% of rated current for 2 hr or 200% of rated current for 1 min. For safety all live parts are enclosed by grounded metal covers or screens. The completely static units have no moving parts except for cooling fans. GE notes that the cars are easy to handle and can be lifted by either end and lowered vertically into a mine shaft. Sulpher hexa-flouride (SF_6) is used as a cooling and insulating medium. It is non-flamable, non-toxic and non-explosive and reduces unit weight to one-half that of liquid-filled transformers, adds the company.

Low-Seam Miner

"Rotobuster," a new continuous miner that can work in seams from 32 to 48 in high, is, in the opinion of Joy Mfg. Co., Pittsburgh 22, the most flexible low-seam miner available today. The miner employs an auger-like drum that sweeps back and forth in the face after sumping in to a 30-in distance. The miner head has two cutting elements, one behind the other. The front cutter mills out coal at 100 rpm clearing a path for the rear or drum cutter during the sump and sweep. The drum cutter, counter-rotating at 34 rpm, breaks out the coal throwing it out of the hole. Maximum room width for the machine is 20 ft with a 26-in-diameter mining head. Rated capacity is 2 tpm.

On the Joy Rotobuster, which can be obtained with sumps running 24 and 36 in, according to Joy, only one sump is made for each cycle. The head swings laterally with each sweep and then up to begin a new sweep. The machine features a cleanup device that consists of two chains each with projecting arms which sweep the fallen coal into a single, hopperless conveyor. The conveyor, 24 in wide, moves coal to the rear of the machine at 265 fpm.

(*Continued on p 140*)

B.F.Goodrich

It's a rugged, rock-strewn strip mine—the place where B.F.Goodrich tires pay off!

TON after ton of rock and overburden crash into that truck, to be hauled out of this Pennsylvania strip mine on a road littered with jagged rock. Trucks work 70 hours a week. Gross loads reach upwards of 44 tons. Sky-high tire costs? Not for this company. They use B.F.Goodrich Rock Service tires. The company reports Rock Service tires give as many as 3,000 hours of service on the original tread—can still be retreaded twice!

B.F.Goodrich builds the Rock Service with a special cut and snag-resisting tread compound. Double-chevron cleats grip the ground, defy dangerous skids. You get more retreadable tires with Rock Service tires, thanks to the B.F.Goodrich FLEX-RITE NYLON cord body. This B.F.Goodrich nylon withstands double the impact of ordinary cord materials, resists heat blowouts and flex breaks. No wonder strip mining is a place where Rock Service tires really pay off!

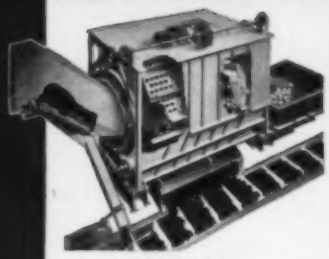
Visit your nearby B.F.Goodrich Smileage dealer today. He has tires for every kind of mining job—tires that will save you money. *The B.F.Goodrich Company, Akron 18, Ohio.*

Specify B.F.Goodrich Tubeless or tube-type tires when ordering new equipment

Smileage!

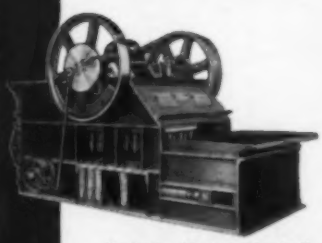
B.F.Goodrich *off-the-road tires*

America's most complete line of CRUSHING EQUIPMENT



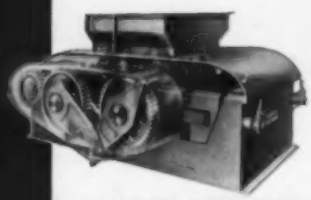
McNally Pittsburg Rotary Breaker

This unit allows positive control of top size in handling run-of-mine washery feed. Production of fines is held to a minimum.



McNally Norton Vertical Pick Breaker

50% Less fines when reducing lump to egg and stove sizes.

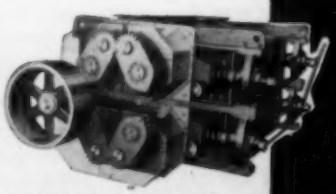


McNally Double Roll Gearmatic ROM Breaker

Built in tonnage ranges from 750 tph to 1400 tph. Full floating gearmatic drive.

McNally Gearmatic Stoker Coal Crusher

This unit offers three prime advantages: high volume production, plus accurate sizing, plus low percentage of fines.



McNally Two Stage Crusher

This unit consists of a double roll primary crusher mounted above a double roll secondary crusher—compactly arranged into a single rigid structure.

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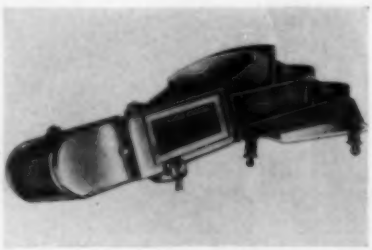
McNALLY PITTSBURG MFG. CORP.

Pittsburg, Kansas Wellston, Ohio

Equipment News *(Continued)*

HEAVY-DUTY IDLERS—Added to the line of Barber-Greene, Aurora, Ill., are two new series of belt conveyor idlers. These idlers are designed for long life and continuous operation while handling large lumps and heavy loads at high speeds. Belt widths range from 18 to 60 in and roll diameters are 6 and 7 in. Among the units available are standard troughing idlers, rubber-impact idlers, picking-table idlers, flat-belt idlers and deep-trough idlers. Both series combine precision-made tapered roller bearings with large shafts, heavy rolls, rugged stands and a new grease seal.



FEEDERS — New overhead-magnet heavy-capacity bulk materials feeders are announced by Synrton Co., Homer City, Pa. The feeders, electromagnetically vibrated 3,600 times per minute, feed even stubborn hard-to-handle bulk materials at easily controlled rates of feed, according to the firm. The units are supplied with separate controllers containing operating switch and control devices.

NEW SHOVEL—Newest addition to the line of power cranes and excavators at Manitowoc Engineering Corp., Manitowoc, Wis., is Model 3100, a 2½-yd shovel that is easily converted to clamshell, back hoe, dragline or crane. Although big in capacity the Model 3100 handles, travels and can be moved from job to job with small machine ease, says the firm. The shovel boom is extra strong because of the use of an exclusive alloy steel boom welded in elongated tubular form. The crowd mechanism of the 3100 is positioned to eliminate off-center strain on the drum shaft and a powerful smooth disc-type clutch on the main drive shaft powers the high-speed retract.

PLASTIC PIPE—Hubbed sewer pipe and a hubbed perforated drain pipe made of high density polyethylene are new from Pyramid Industries, Inc., Erie, Pa. Made from Koppers Co.'s polyethylene, the pipe is unique, reports Koppers Co., because the hubbing is an integral part, eliminating the need for a separate coupling. It is easy to install, can be cut with a handsaw and no adhesives are required, says Koppers. Resistant to acids and alkalis, the pipe won't rust, corrode, nor fracture when abused. The

"THE AMOCO MAN WAS HERE"

A trained Amoco lubrication engineer visited the mine. All equipment was listed. The lubrication requirements of every machine were analyzed on the basis of his thorough training and familiarity with each make and model. Recommended lubricants were chosen from Amoco's complete quality tested line. Each was selected to step up performance, cut downtime and save on the cost of the lubrication itself. That is how many coal mines are saving money. You can, too. Just ask for *your* free Amoco survey. Contact your nearest Amoco office, or the American Oil Co., 555 Fifth Ave., New York 17, N.Y.

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★ **Integrated Socket-clamp. Eliminates screw-socket problems.**

In hundreds of scientific laboratory tests, the combination of revolutionary new components and lamp in Model SRS 115-150 averaged 6000 times longer lamp life than former floodlights. From a few days to months in field tests—that's the amazing record of extended lamp life of this STURDILITE over conventional lights.

MERRITT-CHAPMAN & SCOTT
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3 BIGGEST CONSTRUCTION JOBS IN AMERICA TODAY

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High and low voltage models for all requirements in heavy construction, mining, quarrying, etc. Write for Literature.

PHOENIX PRODUCTS COMPANY
4737 N. 27th Street Milwaukee 9, Wisconsin

Equipment News (*Continued*)

sewer pipe is made in 2, 3 and 4 in dia and 10 ft lengths; the hubbed slotted drain pipe is made in diameters of 2, 3 and 4 in. Price is competitive with fiber pipe and other plastic pipe and is lower than the cost of cast-iron pipe, adds Koppers.

WELDER—American Manganese Steel Div. of American Brake Shoe Co., Chicago Heights, Ill., is marketing a redesigned semi-automatic welder for hardfacing. Lightweight, the machine is useful to build up dipper teeth, dipper lips, crusher-rolls and other parts that cannot be hardfaced with fully automatic equipment. You can connect the semi-automatic welder to any 300 amp or large DC power source, says the firm. The machine feeds hardfacing wire through a hand-held electrode holder whenever the holder switch is depressed.

LUBRICATION SEALS — "Lubseals" are now offered in bright attention-getting colors for use on grease fittings, by Wilson Plastics, Inc., Sandusky, Ohio. Applied to the fittings they prevent the collection of dirt, grit, paint and the like with the hazard of having it forced into the bearing. Availability in different colors, the manufacturer notes, also permits coding for time of application or type of lubricant.

WATERPROOF BOOT — Development of "a new revolutionary leather boot" which is guaranteed waterproof has been announced by Dunham Bros. Co., Brattleboro, Vt. Although "Duraflex" boots will not leak, declares the firm, they allow the foot to "breathe" normally. Available in 6-in and 9-in heights, the boot incorporates "Sylflex (R)"-tanned upper leather which is vulcanized to a cork sole. Stitchless construction and the special leather help keep water and moisture out and the boot dries soft and flexible, even after tests which have "walked" it through 120 mi of water, according to the firm.

TANDEMIZING—General Electric Co., Schenectady 5, N. Y., is offering "do it

The Hauser-Stander Tank Co.
Wood Tanks for Ninety Years
Cypress — Fir — Redwood — Pine
THE BEST YOU CAN BUY
CINCINNATI 32, OHIO

For extra high *strength wire rope...*

use CF&I-Wickwire *Double Gray*

The CF&I Image reflects CF&I's experience as a producer of many steel products and CF&I's versatility in developing new products to meet exacting requirements . . . like Wickwire Double Gray*.

The special steel used in Double Gray provides extra resistance to the deforming effects of peening and crushing which occur on the drums and sheaves of heavy equipment. Double Gray also gives extra resistance to abrasion.

Because of these superior qualities, Double Gray rope quickly repays its slightly higher initial cost in safer, more economical operations. Use it wherever extra high strength wire rope is required.

For a free copy of our Double Gray booklet, write to: Advertising Department, The Colorado Fuel and Iron Corporation, 575 Madison Avenue, New York 22, N. Y.

**Wickwire Double Gray Wire Rope is made of extra-improved plow steel. Fortified by an independent wire rope core of the same extra high strength steel, Double Gray rope has a 15% higher breaking strength than the catalog breaking strength of an improved plow steel rope with IWRC.*

6432

WICKWIRE ROPE

THE COLORADO FUEL AND IRON CORPORATION

In the West: **THE COLORADO FUEL AND IRON CORPORATION**—Albuquerque · Amarillo · Billings · Boise · Butte Denver · El Paso · Farmington (N.M.) · Fort Worth · Houston · Kansas City · Lincoln · Los Angeles · Oakland · Odessa (Tex.) Oklahoma City · Phoenix · Portland · Pueblo · Salt Lake City · San Francisco · San Leandro · Seattle · Spokane · Tulsa · Wichita

In the East: **WICKWIRE SPENCER STEEL DIVISION**—Boston · Buffalo · Chattanooga · Chicago · Detroit · Emlenton (Pa.) New Orleans · New York · Philadelphia

CF&I STEEL

70 S—BDT

KW-DART HAS

COAL SAVVY

. . . . . superior performance is "engineered in." The right components — in the right combination — built on the right chassis and suspension system result in greater production and reduced maintenance costs.

Why does KW-DART know which are "right?" The answer is experience — a "savvy" from building trucks for coal companies since open-pit operations began.

Performance figures and maintenance records are available for your study — may we have a KW-DART sales engineer arrange a visit with you?

35 T

KW-DART TRUCK CO.

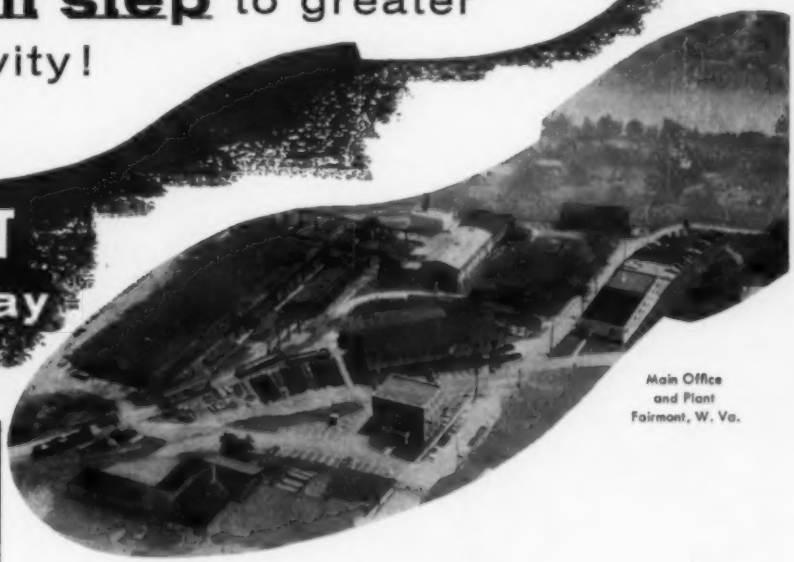
Subsidiary of Pacific Car and Foundry Company

1301 North Manchester Trafficway | P. O. Box 321 | Kansas City 41, Missouri, U. S. A.

Today's preparation and handling equipment takes **a giant step** to greater productivity!

and

FAIRMONT shows the way



Main Office and Plant
Fairmont, W. Va.

UNLOADING

Car retarders and hoists, car shakers, unloaders, rotary-car dumpers, portable conveyors, track hoppers, grizzlies, feeders, weighing devices.

TRANSFER

Skip hoists, bucket elevators, belt and flight conveyors, mass-flow and screw conveyors, stacking conveyors.

PREPARATION

Crushers and breakers, screens and dryers, washing equipment.

STORAGE

Bins, bunkers and silos, bin flow devices, indicators and alarms, vibrators, gates and valves.

IN-PLANT HANDLING

Conveyors, elevators, chutes, scales, meters and samplers.

Ever changing conditions and demands by industry pinpoint requirements that depend more and more on systems and modern machines geared to the tempo of the age!

Coal, a major industry, is part of this trend to greater productivity and improved quality. Fairmont Machinery, with over 60 years experience, is keenly alert to these rapidly changing times and is making every effort, through research and development, to provide you, the operator, with the most efficient and economical methods for handling, preparation and storage.

Fairmont is equipped and ready to produce for you—whether a complete preparation or cleaning plant; an entire or partial operating system; or the modernizing of your existing facility.

Why not call us today for a get-together with you.

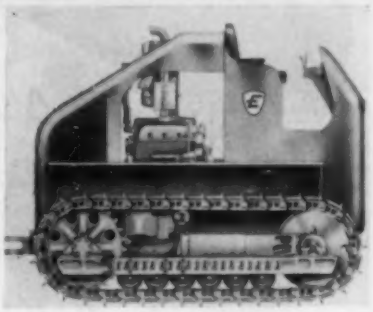
FAIRMONT
MACHINERY COMPANY
FAIRMONT, WEST VIRGINIA

ENGINEERS • DESIGNERS • FABRICATORS and CONSTRUCTORS

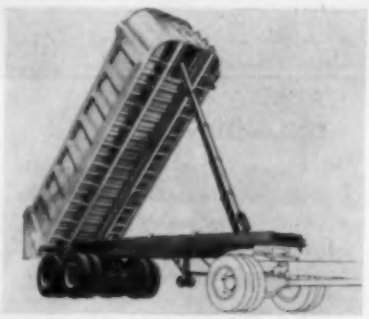
Equipment News (*Continued*)

yourself" kits enabling mine operators to tandemize their old two-axle motors regardless of make or model, upgrading them to main line haulage units. Modernization can also be accomplished in GE's service shops, these jobs including such additional features as balanced air-brake design and restoration of machined fits to "like new" tolerances.

NEW TRACTOR — The new Series 103, a smaller companion tractor to the larger 105, is a product of The Eimco Corp., Salt Lake City, Utah, and introduces a new construction feature the company calls "unitized stress flow construction." This method of casting heavy steel in large sections with the casts molded to the scientifically established stresses and shapes required, enabled Eimco to cast the entire track frame and diagonal brace of the new 105 in one piece. The final drive, center housing and main frame are also produced in one heavy steel casting without bolts or welds. Another feature cited by Eimco is called "Quadra-Torque," which is a power team of heavy-duty high-efficiency torque converter and Eimco's

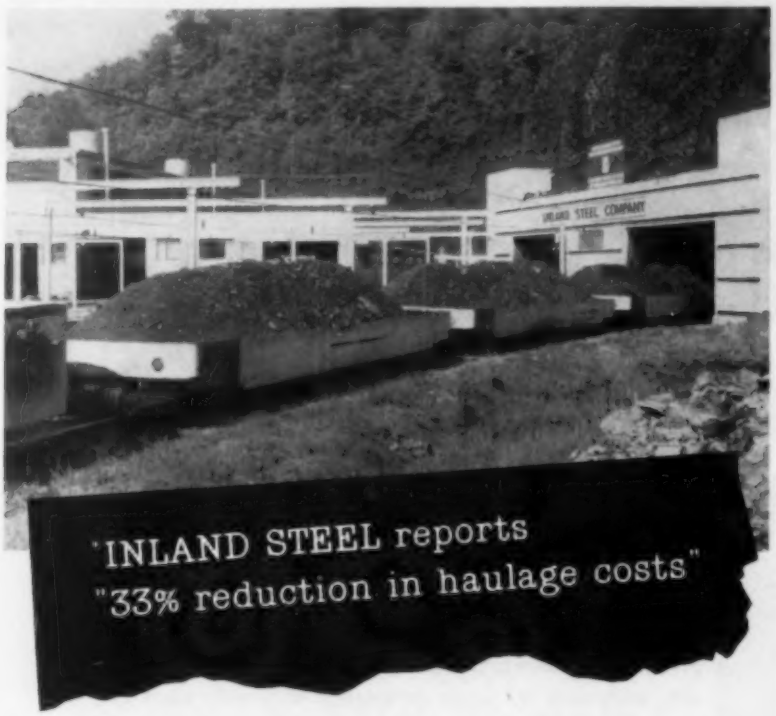


"Unidrive" teamed with dual final drives, offering full hydraulic actuation on 4 forward and 4 reverse gears by the flip of a lever . . . and at any speed. Independent track operation permits smooth spin turns by running one track forward and the other in reverse.



ALUMINUM BODIES — A new line of aluminum dump trailers featuring substantial weight savings and greater corrosion resistance has been introduced by Galion Allsteel Body Co., Galion, Ohio. Adaptable to any single or tandem trailer chassis, the new aluminum body line specifications call for 3/16-in sides and floors, 4-in channel crossmembers and 5-in I-beam longitudinals (when specified). Galion supplies the entire aluminum trailer package including: body, hoist and chassis mounted with tractor kit; I. C. C. lights and reflectors and mud flaps.

SUBMERSIBLE MOTORS—The Louis Allis Co., Milwaukee 1, is producing a new 4-in submersible motor for deep-well turbine pumps. It provides the highest horsepower capacity in a motor of that diameter, says the firm. Ratings offered in single-phase construction are from ⅓ to 5 hp. In 3-phase construction ratings extend from 1½ to 7½ hp at 3,550 rpm. Using an outside-wound stator greater horsepower capacity for size is achieved, notes the firm. A special design feature cited is a self-equalizing thrust bearing with a carbon thrust pad and six self-aligning, hardened, stainless steel tilting shoes mounted on a spherical seat. This insures reserve thrust



SOUND LIKE A GRAVY TRAIN? Maybe so, but it's actually down-to-earth mine car trains that we're talking about.

Inland made exhaustive studies over a three year period . . . came to the sober conclusion that their mine car investment "would be returned in 2½ to 3 years."

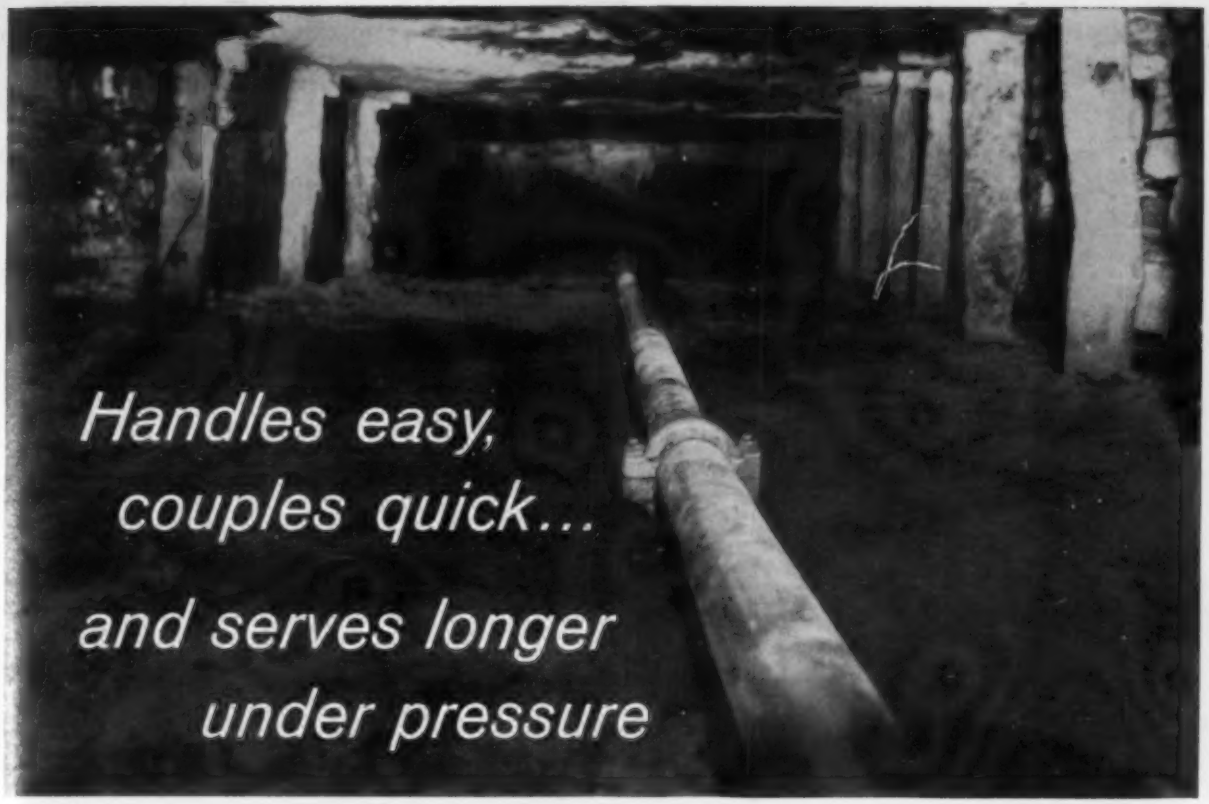
The well loaded trip shown above is a part of the 526 *additional* cars purchased by Inland for its Wheelright Mine as a result of its experience with Differential cars in their Price #2 mine.

Standing out like a miners' lamp underground is the irrefutable, hard fact that for any given length, width and height mine car you can haul more tons of payload in a Differential than in any competitive make. Make us prove it!

It's the popular "Axless" truck design that makes the difference in Differential. Leaves more room within the car for revenue producing coal. Look into the Differential deal—it's sound as a dollar!

DIFFERENTIAL STEEL CAR COMPANY
FINDLAY OHIO

SINCE 1915 PIONEERS IN HAULAGE EQUIPMENT



lightweight REYNOLDS ALUMINUM MINE SERVICE PIPE

Reynolds Aluminum Mine Service Pipe provides the corrosion-resistance, flexibility and ease of installation necessary in today's profitable mine operations! Aluminum Mine Service Pipe weighs less than one-third as much as steel pipe—yet can last up to eight times longer. Aluminum's high strength-to-weight ratio enables it to withstand pressures and abuse from rough terrain and rock falls that plastic pipe could never take.

Compare the weight and bursting pressures of other pipe with Reynolds Aluminum Mine Service Pipe. Then compute the installation savings possible with lightweight aluminum. Consider aluminum's strength under varying temperatures. Think of the possibilities of re-use and temporary installations . . . ease of coupling . . . conformability to terrain.

Then call your Reynolds Aluminum Mine Service Pipe Distributor. For his name, or additional information, write *Reynolds Metals Company, Box 2346-NQ, Richmond 18, Va.*

REYNOLDS ALUMINUM SCHEDULE 5 PIPE

Nominal Size (inches)	Wt./100 ft. (pounds)	Lengths (feet)	Approximate Bursting Pressure (lbs./sq. inch)
1¼	38.3	20-30-40	2350
1½	44.1	20-30-40	2050
2	55.5	20-30-40	1635
2½	85.6	20-30-40	1730
3	104.8	20-30-40	1420
4	135.4	20-30-40	1100

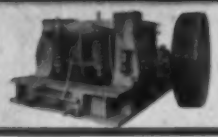
The Finest Products Made with Aluminum are made with REYNOLDS ALUMINUM

Watch Reynolds TV show—
"WALT DISNEY PRESENTS"—
every week on ABC-TV

McLANAHAN SINCE 1835

CRUSHERS for COAL and REFUSE

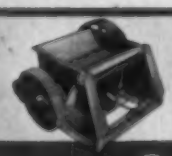
SINGLE ROLL



Rockmaster — High in capacity and ruggedly constructed, it crushes hardest rock, slate and similar mine refuse.

Super Black Diamond — An all-steel, intermediate-duty crusher, this provides many Rockmaster features at moderate cost.

Black Diamond — Steelstrut Toggle protection against uncrushable materials and quick size adjustment are features of this fabricated steel crusher.



Bantam Buster — This is a portable, low-cost unit with a high ratio of reduction. Trouble-free maintenance is a feature.

DOUBLE ROLL

Black Diamond Double Roll — This was designed for moderate to fine reduction of coal where a low ratio of reduction is satisfactory.

Heavy-Duty Double Roll — Economical and noted for service, it is ideal for fine reduction of mine refuse.

TRIPLE ROLL

Black Diamond Triple Roll — Radically new 2-stage design reduces run-of-mine and direct open pit feed coal to fine sizes.

Bulletins Available on All Crushers

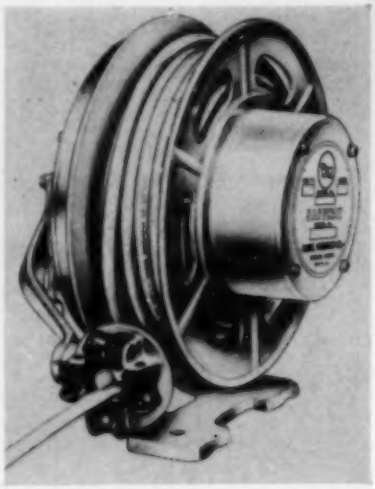
McLanahan and Stone Corporation

250 Wall Street, . . . HOLLIDAYSBURG, PA.

Mine, Pit and Quarry Headquarters Since 1835

Equipment News (*Continued*)

capac'ty and long bearing life, states Louis Allis.



CABLE REELS—"Job-rated" automatic power cable reels have been announced by the Daniel Woodhead Co., Chicago, Ill. The reels feature new "add-on" collector rings so that reel capacity can be increased to handle any number of conductors when necessary. Reels are available in four basic diameters: 1½ in, 15 in, 20 in and 24 in, as well as in large-size special reels.

DIESEL TRUCK — This giant new diesel tractor is a new product of Dodge Mfg. Co., Detroit 7. The tandem tractor, first 1960 Dodge model shown publicly, is powered by a Cummins NH-220 engine. The NH-220 is only one of four Cummins engines to be available in 1960. New diesel trucks will offer maximum gross combination weight rating of 76,800 lb, more than 15% greater than Dodge offers on present models, says the firm. Truck models with gross vehicle weight ranges from 27,000 to 53,000 lb and gross combination weight range from 50,000 to 76,800 lb will be available.

NEW ENGINES — Three new heavy-duty engines designed for a wide variety of power applications have been an-

A-W Hydraulic Crane speeds repairs on giant shovel at Bagdad Copper Corp., Bagdad, Arizona. It also saves many costly man-hours on a host of other lifting jobs. The maintenance superintendent calls it the "handiest darn machine around here."

AUSTIN-WESTERN... speeds production, reduces downtime

A-W Hydraulic Crane saves maintenance man-hours

This is the most versatile tool yet developed for maintaining heavy mining equipment. Carries loads up to 5 tons, swings, lowers and spots them into exact position. All boom movements—raising, lowering, swinging and telescoping—have finger-tip hydraulic controls that can be used individually or simultaneously. All-wheel drive and oversize tires take it over the toughest terrain. All-wheel steer and a turning radius of 15 ft. 8 in. get it in and out of the tightest quarters, indoors and out. Can haul and spot cars on your sidings, yard or pit. As a rule, it will pay for itself in the first year by speeding repairs, slashing downtime, and saving labor.

A-W Power Grader at work in open pit mine of Midland Electric Coal Co. at Farmington, Illinois

A-W Power Grader for rugged road jobs

A-W Power Graders with all-wheel drive give you 30% more power where it counts—at the blade. In addition, this extra tractive power lets you grade access and haul roads where other machines would be hopelessly bogged down. All-wheel steer allows extreme maneuverability. Because of its power and stamina, an A-W equipped with a bulldozer attachment often saves the cost of a tractor-bulldozer.

Get complete information on these time and moneysaving machines from your nearby A-W distributor or write direct

Austin-Western CONSTRUCTION EQUIPMENT DIVISION, AURORA, ILL.

BALDWIN · LIMA · HAMILTON

Power graders • Motor sweepers • Road rollers • Hydraulic cranes

How to splice a portable cable so you can *REALLY* depend on it

Portable mining cable *can* be spliced dependably and safely—avoiding the costly and time-consuming shutdowns that often stem from faulty splices. But to insure safe splices, proved engineering practices must be followed. Here's how these concepts can be put to use:

1. "Duplicate" the cable

The compound used for insulating a cable is specifically designed for its job. Therefore, when a portion of the insulation is removed in making the splice, it stands to reason that the insulation should be replaced—or "duplicated"—with the same material, a true cable-insulating compound. Too often, however, the splicer uses any tape that's "handy", a tape that can be used for a hundred other purposes.

2. Use true cable compounds

Fortunately, there are splice insulating tapes made of true cable compounds—Okonite tapes, developed by the same company that manufactures superior electrical cable. Okonite tapes, made with fine Para rubber, actually fuse into a solid, layerless, non-porous wall of moisture-resistant insulation . . . with no voids to cause break-downs and no adhesives to dry out, ooze, or cause slippage of the tape wrappings. They make the splice an actual extension of the cable—not a weak "link" in it.

3. We recommend these tapes

Although your portable mining cable may take a continual beating, your splices will stand up to it with Okonite tapes—Okolite for insulation; Okoprene or Okoweld and Manson for sheathing. The Okonite Engineering Department will be glad to furnish you with instruction sheets to help you with your splicing problems. Ask your Okonite representative.

THE OKONITE COMPANY

Subsidiary of Kennecott Copper Corporation
Passaic, New Jersey

6473

Equipment News (*Continued*)

nounced by International Harvester Co.'s Construction Equipment Div., Chicago 1. The units are two compact 6-cylinder carbureted models, UC-263 and UC-221, and the 4-cylinder carbureted UC-135. The UC-263 develops 95 hp at 2,400 rpm; the UC-221 produces 75 hp at 2,400 rpm; and the UC-135 develops 42 hp at 2,000 rpm. Features cited are fuel-savings, efficient valve in head design; long-life pressure lubrication; replaceable sleeves and factory sealing.

IN-LINE REDUCERS – Philadelphia Gear Corp., Philadelphia 34, has available two new large-size gear speed reducers as additions to its existing series of in-line drives. Rated to 200 hp, these units are the largest standard speed reducers ever produced, according to the firm. They feature efficiency of 94 to 97% depending upon the number of reductions required, it is noted. To achieve maximum strength and dependability, helical gearing is carburized and hardened and gear teeth are precision ground, resulting in increased load-carrying capacity to handle the most severe overhung loads and shock conditions, declares the company.

RADIOPHONE—A portable two-way radiophone designed to block out inter-

JOY ELECTRICAL EQUIPMENT for the coal mining industry

Lectronic Sentry

Protects against ground faults and short circuits on all D.C. operated off-track mining machines and trailing cables. Continuous monitoring signal between transmitting and receiving elements is interrupted when trouble occurs, and circuit breaker instantaneously cuts power to machine and trailing cable. *Requires no grounding conductor*, permits use of lower cost 2-conductor cable.

CABLE VULCANIZER

Bench model vulcanizer for fast, safe, economical cable repairing and splicing. Accommodates molds for patching, splicing, special Y splices, T tap-offs, etc. Vulcanized area is as watertight, flexible and permanent as original cable covering. Includes temperature selector for both platens, pressure regulators up to 25 tons. Handles molds up to 6" wide, for cable up to 5" in diameter. Can be used in tandem for extremely long splices. Available for standard factory voltage, A.C. or D.C. Portable model also available.

CONNECTORS

Hi-Voltage Type

Multiple conductor high voltage connectors are designed for operation up to 7500 volts. Each unit is fabricated in two stages; (1) primary molding securely embeds each contact and conductor wiring junction in highly resistant, void-free Butyl. A (2) secondary molding encloses all contacts inside a resilient Neoprene body and permanently vulcanizes it to its chosen cable.

Straight Pin Bigun Style

With threaded metal couplings for positive engagement and disengagement. Completely watertight when engaged. Molded to 36" leads, or other lengths as specified. Two types of waterseals insure perfect operation, even under water or in dust choked atmospheres.

Quik-Loc Style

Similar to Straight Pin Biguns, except square cut groves and lead pins are used instead of machine threads. Engage and disengage in ¾ turn. Attach quickly and easily to cable or can be ordered now molded to cable as required.

Oval Style

For general, all-round electrical connection requirements. Lies flat, offers less obstruction. Reinforced at cable-connector junction with taper-neck vulcanization.

For consistent quality and dependable performance, specify Joy electrical equipment specially designed for mining applications.

Insist on the Orange Dot!
the mark of quality

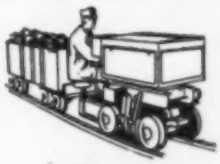
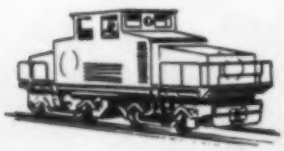
JOY ELECTRICAL PRODUCTS DIVISION

Write for Descriptive Bulletin B73

CD-759.1

1205 Macklind Ave., St. Louis, Mo.
Exec. Offices, Henry W. Oliver Bldg., Pgh., Pa.

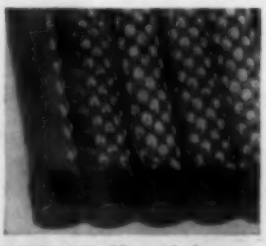
NEW EXIDE-IRONCLAD LOCOMOTIVE BATTERIES PACK UP TO 45% MORE POWER

APPLICATION	NEW TYPE BATTERY	CAPACITY PER POS. PLATE	REPLACES BATTERY TYPE	PERCENT CAPACITY INCREASE
 Trammers	MG	45 ah	MVM ML	32.4 17.5
Mine locomotives	RG	55 ah	ML TLM	43.6 5.0
Shuttle cars	TG	72 ah	TLM TH	44.0 20.0
 Battery locomotives	TEG	95 ah	(new type—no prior data)	
	MEG	145 ah	MEH MEX	45.0 21.0

Boost the work capacity of your locomotives

These new, advanced Exide-Ironclad Batteries pack more power in the same space. They equip your present locomotives to do more work. And they actually cost less per ampere-hour, promise even longer life of service. Get complete information. Call your nearby Exide representative. Or write Exide Industrial Division, The Electric Storage Battery Company, Philadelphia 2, Pa.

Exide



THE SECRET. New tubular construction packs more power in each positive plate . . . prolongs battery life.

Equipment News (*Continued*)

ference from other radio systems on a user's line is new from Motorola, Inc., Chicago 1. "Private Line" works on a tone-coded squelch principle. The transmitters have an inaudible tone sensitive to interference which is thereby blocked out. The units come in low- and high-powered versions in the 25-50 mc and 144-174 mc frequency bands. They weigh from 7 to 18 lb depending on the unit's power and type of battery.

Equipment Shorts

Hooks – High-strength hooks made from Type 8620 alloy steel are products of American Chain Div., American Chain & Cable Co., Inc., York, Pa. They can be used with chain assemblies as well as with the firm's Kuplex sling chain. The hooks accommodate ¼-, ⅜-, ½-, ⅝-, ¾- and ⅞-in chain sizes.

Warning Switch—An explosion-proof hermetically-sealed low-level warning switch for use in almost any liquid has been announced by Divac Div. of Acme Machine Works, Hawthorne, Cal. Said to be extremely accurate and reliable, the new switch, installable on warning lights or automatic switching mechanisms to start pumps or open auxiliary lines, cannot be fouled by contamination of fluid and is unaffected by rolling or pitching motions, according to the maker.

Soft-Face Hammer—Proto Tool Co., Los Angeles, Cal., has added to its tool line a new low-cost soft-face mechanic's hammer said to have unusual features.

Non-sparking because of no exposed parts, the tool is tough and light-weight, says the firm. Plastic replaceable tips won't mushroom or flake off and are resistant to grease, oil and common acids, it is added.

Floodlights – Light-weight Fire-Chief portable floodlights made to travel anywhere are produced by Stonco Electric Products Co., Kenilworth, N.J. One model is a completely vaportight portable for use wherever excessive fumes, dust or water are present. The lights are easily adjustable and have large cast-aluminum knobs for focus lock-in at any angle.

Belt Dressing—A new dressing in aerosol form that can be sprayed on moving transmission belts, has been developed by Graton & Knight, Worcester 4, Mass. Called "Sprazon," the belt dressing is reported to be completely safe because workmen's hands and arms need never be in the way of moving belts or pulleys. The dressing does a more effective job of preventing belt

NEW ACME HI-LIFT

MODEL HSHL-4B

For Best Results in High-Vein Roof Bolting

The ACME (Model HSHL-4B) HI-LIFT is an innovation in modern mining technique designed to facilitate roof control in high-vein mining operations. The ACME HI-LIFT is a four-wheel drive, tractor type steering, unit with an elevating drilling deck on which are mounted two traveling and traversing Le Roi S12VT Nu-Matic stopers. The elevating platform enables the operator to work at the most convenient height for greatest efficiency. The stopers move on a traveling rail thereby permiting drilling at virtually any spot on the platform. The drills are of the integral dust collecting type and the dust collectors are mounted beneath, and on the sides of, the platform. Safety timbers can be placed between the platform and the roof to afford protection to the operator from roof slabbing and falls. The platform will support a 30,000 pound weight and can be tilted 15 degrees front to back. In addition the ACME HI-LIFT has four leveling jacks with an effective stroke of 10″ for leveling in bad bottom or on high grades. Two complete sets of controls are furnished as standard equipment, one being on the platform and one on the tramming deck. A powerful 40 HP motor drives the complete hydraulic system for the unit.

COMPLETE SPECIFICATIONS WILL BE GLADLY FURNISHED UPON REQUEST

ACME MACHINERY COMPANY

ACME MACHINERY COMPANY

WILLIAMSON, WEST VIRGINIA

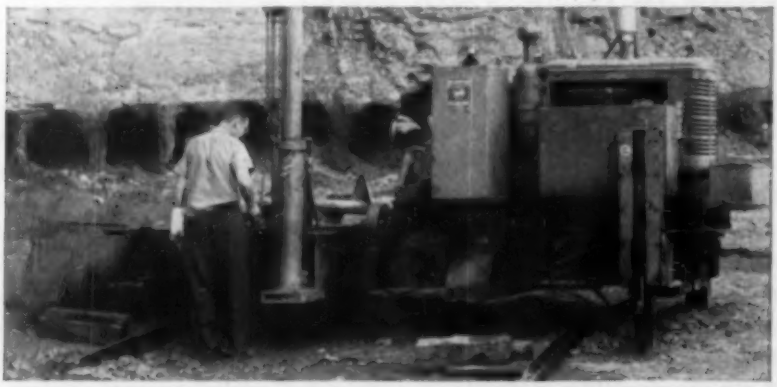
WAREHOUSE AND SALES OFFICE
MORGANTOWN, W. VA.

REPRESENTATIVES IN PRINCIPAL MINING AREAS

Aeroquip Flexible Hose Lines Reduce Downtime on All Mining Equipment

Replace worn or damaged hose lines quickly by assembling Aeroquip Hose and Reusable Fittings right in the mine. A small inventory of bulk hose and reusable fittings meets all your requirements. You save money because equipment gets back on the job faster.

FOR DEEP MINE EQUIPMENT, Aeroquip Hose Lines provide dependable performance under all working conditions. The Aeroquip hydraulic lines on this stoper withstand abrasion, flexing and shock.



FOR STRIP MINE EQUIPMENT, Aeroquip Hose Lines perform well in many jobs. This rock drill, for instance, uses low-cost *SOCKETLESS* Fittings and Hose for engine fuel and air lines as well as Double Wire Braid Hose and Fittings for high pressure hydraulic lines. *SOCKETLESS* is an Aeroquip Trademark.

CALL THE AEROQUIP DISTRIBUTOR LISTED IN YOUR YELLOW PAGE PHONE BOOK

Aeroquip

REG. TRADEMARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

INDUSTRIAL DIVISION, VAN WERT, OHIO • WESTERN DIVISION, BURBANK, CALIFORNIA
AEROQUIP (CANADA) LTD., TORONTO 19, ONTARIO

SOCKETLESS Fittings are Covered by U.S. Patent Number 2,805,088 and Corresponding Foreign Patents and Patent Applications.

Equipment News (*Continued*)

slip and prolonging belt life, according to the firm.

Portable Balancer—A sensitive portable balancer, easily operated to provide vibration analysis of all types of assembled machinery, has been announced by Stewart-Warner Corp., Chicago, Ill. The highly-sensitive instrument, adjustable to any job from below 10 millionths of an inch to over 1/10 to ⅛ in amplitude of vibration is ideal for eliminating vibration in grinding, wheels and cutter heads for finer finishes and closer tolerance work, says the firm.

V-Belt—A combination timing belt and V-belt that permits power transmission with both sides of the belt has been introduced by United States Rubber Co., New York. This is said to be the first type of double-duty belting enabling users to take advantage of a positive drive, non-slip timing belt.

Free Bulletins

Screens—A folder aimed at simplifying ordering of precision space screens is now available from Wickwire Spencer Steel Div. of The Colorado Fuel & Iron Corp., New York 22. The folder describes both types of screen fabric and also offers descriptive information on standard types of hooking available.

Pump Chart—A chart for selecting pumps for strip coal mining is a service of Marine Products Co., 515 Lycaste Ave., Detroit 14. The user can get the exact pump needed by knowing the approximate amount of water to be pumped, the distance from the water up to the pump, the distance from the pump to the end of the discharge line and the height of the discharge line above the pump.

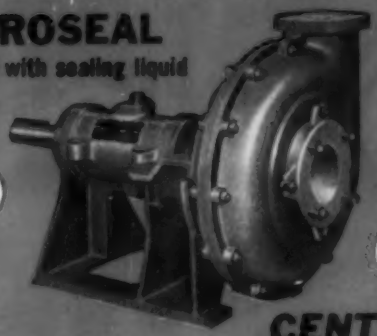
Battery Chargers—Vertically-mounted motor-generator battery chargers saving up to two-thirds on floor space are described in a bulletin from Exide Industrial Div. of The Electric Storage Battery Co., Philadelphia 20. By mounting the simplified lightweight chargers overhead on pillars or walls, the bulletin notes, floor space requirements can be eliminated entirely. Designed for lead-acid batteries used in electric industrial trucks, the single-circuit chargers are offered in four physical sizes covering 25 capacity ranges up to 800 amp-hr.

Screen Enclosures—Dust-tight enclosures for floor-mounted single-, double- and triple-deck Riple-Flow vibrating screens are described in new literature released by Allis-Chalmers Mfg. Co.,

Engineered pumping of abrasives corrosives acids

INTERCHANGEABLE

HYDROSEAL
operates with sealing liquid



Split-Shell SLURRY and SAND Type
2" to 14"

Brochure No. 457

Brochure No. 557

CENTRISEAL
delivers the pulp undiluted

RUBBER-LINED PUMPS

HYDROSEAL
VERTICAL
sump pump

Brochure No. 757

RUBBER-LINED or ALL-METAL
Four sizes: 1½" to 6"
Slurry, Sand & Dredge

PACKLESS Pumps

No stuffing box
No packing
No mechanical seal
No liquid seal
No exposed metal parts

Capacity range:
25 to 600 GPM

Brochure No. 857

Flex-Check Valves
RUBBER-LINED

For pipe diameters up to 12"
For solids up to ¼"

Brochure No. 957

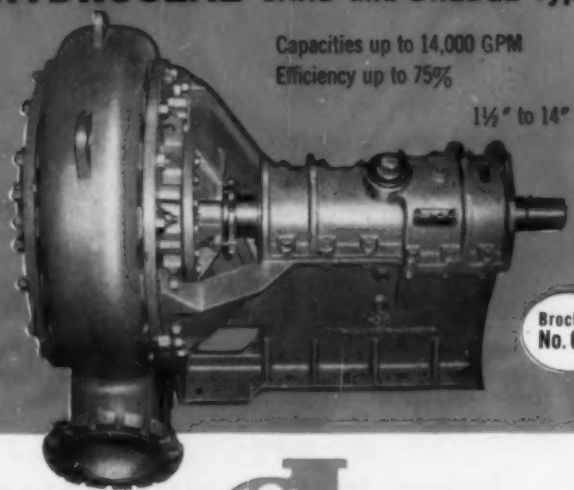
METAL PUMPS

Brochure No. 357

To have an easy key to the correct type and size of pump, write us for "Technical Data" Brochure No. 357. For information in the category of your need, use the specified number. In the refinements of application, our engineers can help you.

HYDROSEAL SAND and DREDGE Type

Capacities up to 14,000 GPM
Efficiency up to 75%
1½" to 14"

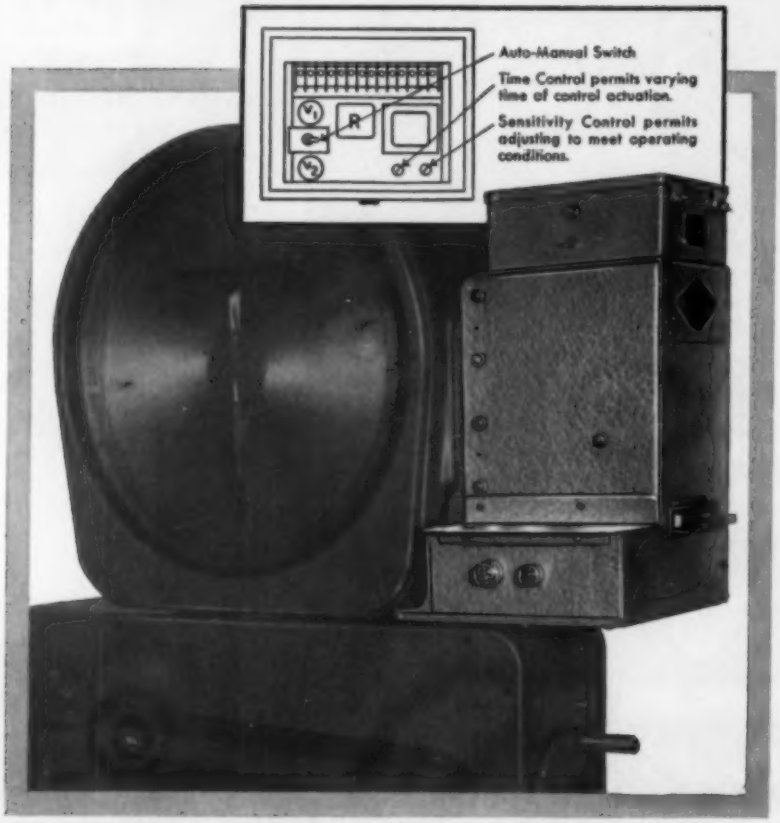


Brochure No. 657

THE ALLEN-SHERMAN-HOFF PUMP CO.
Dept. D—P.O. Box 635, Paoli, Pa.
Representatives throughout the World

HYDROSEAL and CENTRISEAL
SAND, SLURRY & DREDGE PUMPS
MAXIMIX RUBBER PROTECTED

NEW Fairbanks-Morse Electronic Weight Detector


Auto-Manual Switch
Time Control permits varying time of control actuation.
Sensitivity Control permits adjusting to meet operating conditions.

Prevents incorrect weighing . . . stops costly errors!

With the new Electronic Weight Detector, true weight of any load can be automatically obtained and recorded without need of a weighman. Where a weighman is used, it is impossible for him to record incorrect weights or start a sequence at the wrong time. When desired, a flip of the switch can disengage the Weight Detector entirely from the system. *This is the first fully-reliable control of its kind available in the scale industry.*

To completely automate your weighing—to be sure that your weights are correct—to protect yourself by completely policing your entire weighing operation—contact your nearby Fairbanks-Morse Field Engineer, or write directly to Fairbanks, Morse & Co., 600 South Michigan Ave., Chicago 5, Illinois for complete information.

See Sweet's Plant Engineering File for full line of F-M Scales

FAIRBANKS-MORSE
a name worth remembering when you want the BEST

SCALES • PUMPS • DIESEL, DUAL FUEL AND GAS ENGINES • ELECTRIC MOTORS GENERATORS • COMPRESSORS • MAGNETOS • HOME WATER SYSTEMS

Equipment News (*Continued*)

Milwaukee 1. The enclosures' sturdy stationary supported frame is built to accommodate a vibrating screen equipped with standard resilient mountings, notes the booklet.

Lubricants—Bulletin 121, a Molykote lubricant selector chart to facilitate the choice of a proper lubricant for extreme pressure jobs, has been published by the Alpha-Molykote Corp., Stamford, Conn. It evaluates every type in the Molykote lubricant line based on temperature, environment, method of application, operations and conditions.

Dipper Teeth—Covering the new Simplex two-part tooth offered by American Manganese Steel Div., American Brake Shoe Co., 389 E. 14th St., Chicago Heights, Ill., a 16-p catalog lists over 400 tooth point and tooth adapter models to suit every make of shovel, dipper and backhoe.

Tractors—The Eimco Corp., Salt Lake City 4, Utah, has issued a 16-p booklet covering their Eimco 105 series of tractors and tractor units. Included are full-color pictures and specifications on each unit.

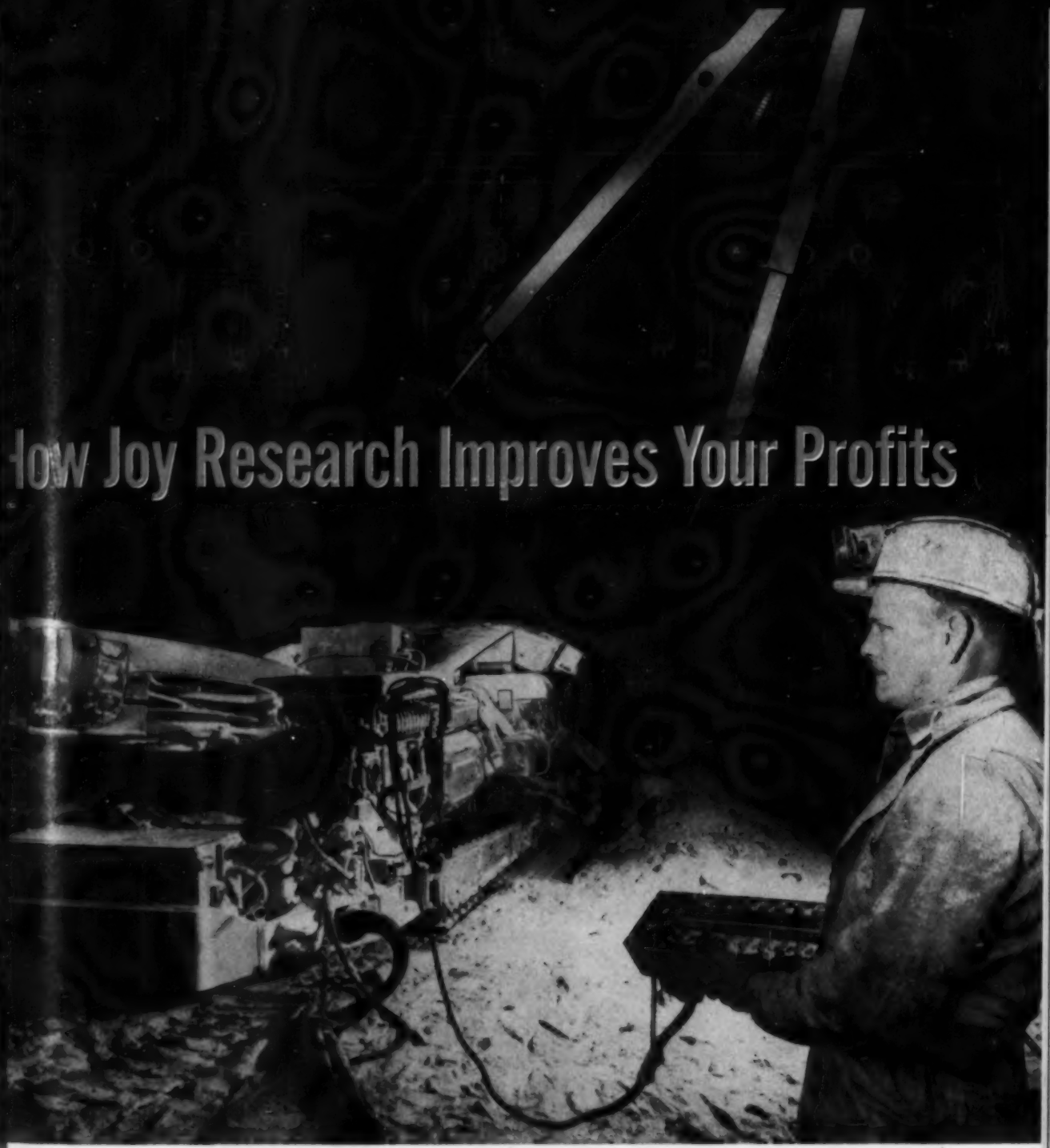
Pumps—Morris Machine Works, Baldwinsville, N.Y., has released Bulletin 180 describing capacities and ranges of its new Type CK solids pump. The unit is designed to handle fluids containing random size solids and highly abrasive material.

Control Panels—Automatic control systems are described in a bulletin from Control Panel Corp., 517 W. Monroe St., Chicago 6. The panels can be built to user specifications or designed for specific duty. Industry uses are listed as well as data on numerous specific applications.

Clean Air—Damage to equipment by compressor air contamination is the subject of Catalog No. 459, Logan Engineering Co., 4901 W. Lawrence Ave., Chicago 30. The booklet tells the manner in which the Logan "Aridifier" prevents equipment damage by removing 92% of all moisture, oil, dirt and fine scale in the air line between compressors and equipment using the air.

New Engine—The new UDT-817 is discussed in a 4-p folder just released by International Harvester Co., Consumer Relation Dept., 180 N. Michigan Ave., Chicago 1. The most powerful International diesel engine ever built, the UDT-817 develops 385 hp at 2,100 rpm. The folder has sectional and cutaway photos as well as fuel consumption graphs and performance curves.

How Joy Research Improves Your Profits



Joy's development program produces entirely new methods . . . like this remote control system for the Twin Borer Miner

From Joy's continuing program of research and development comes a steady stream of new and improved products. The trend has been to more powerful machines, lower machines, more compact machines. Progress in safety, in economy of operation, in ease of maintenance are possible only if inquiring minds are constantly at work seeking new and better ways to do things, new and better ways to build the equipment upon which profit and loss are so dependent. We promise that these programs will continue in the future. Here, Joy reviews some of the new products introduced in the past few months to make mining more profitable.

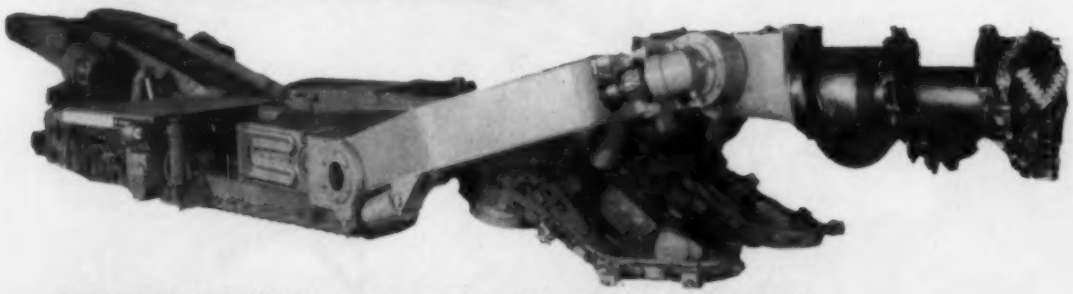
NEW FEATURES ON JOY TWIN BORER . . . remote control and an integral air cleaner have been added to Joy's Twin Borer for mining 6 to 8 ft. seams.
Remote Control . . . the operator controls the machine by using a lightweight control box connected to the Twin Borer by 50 feet of detachable cable. This is helpful when the Twin Borer must make turns or move in narrow places, and more important, the operator is able to stay under well-supported roof at all times. Air Cleaner . . . to eliminate dust and improve visibility, Joy has developed a compact air cleaner that sucks in 6000 cfm of dust-laden air at the face, cleans it and forces it back through flexible tubing mounted on the miner.

The RBM-1 rated at 2 tons per minute provides low seam flexibility to adapt to a wide range of mining conditions. Here's how: the 26 in. dia. mining head bores 30 in. into the coal, then sweeps sideways across the face, breaking out the coal in its path. When it reaches the opposite rib, the mining head shears upward, then sweeps back across the face. This completes the cycle. The head swings 45° to either side to mine rooms and crosscuts 14 to 20 ft. wide in 32 to 48 inch seams. The conveyor also swings 45° to either side. This is versatility unmatched in *any* low seam miner.

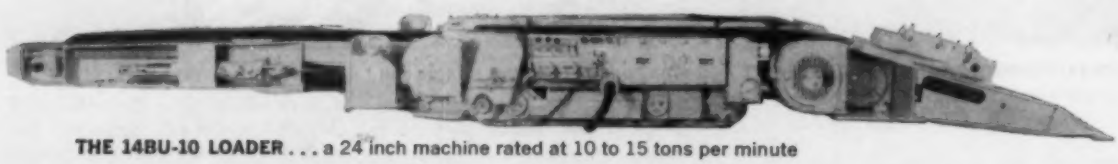
The 14BU-10 has tremendous capacity for its size . . . a big 74 HP in a 24 inch loader. Faster gathering arms and a bigger head, 12 inches wider, crowds into more coal. A wider, lower conveyor—30 inches wide with a pan line just 14 inches high—moves coal out fast with plenty of clearance for large lumps. Mechanically simple and easy to maintain, the 14BU-10 is the loader that low seam operators have been waiting for.

The 18SC only 27 inches high, carries 4½ tons, *twice* the capacity of any other low seam car. The secret is the unique 6-wheel design. The problem of capacity vs. wheel size was solved by adding two wheels at the center and reducing the size of all wheels. This lightens the load on all tires and gives the car a wide, straight-through conveyor without wheel wells. —27 feet long—empties in 20 seconds. To travel over rolls and bumps at high speed, the 18SC is hinged to bend up and down in the middle. The two center wheels are each powered by a 10 HP motor, reducer and chain drive. Thus shifting transmissions, torque converters and differentials are eliminated.

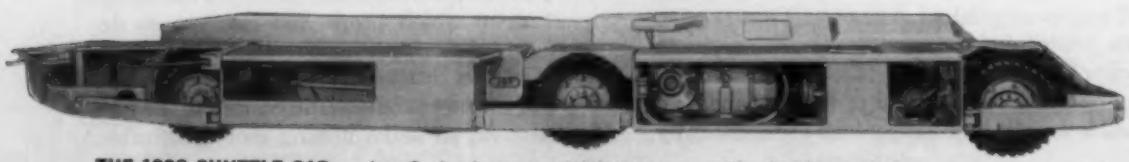
FOR LOW SEAMS



THE ROTOBUSTER MINER . . . a new way to mine coal in seams as low as 32 inches.



THE 14BU-10 LOADER . . . a 24 inch machine rated at 10 to 15 tons per minute



THE 18SC SHUTTLE CAR . . . has 6 wheels, a completely new concept in shuttle car design.

The 6-CM is realistically rated at 5 to 5½ tons per minute, and can rip out and load coal faster than any machine ever built. There are plenty of reasons: Higher horsepower . . . a total of 345 HP. Straight-through hopperless conveyor 30 inches wide. Gathering arm cleanup—independently powered—can do auxiliary cleanup while waiting for shuttle cars. Bigger ripper head . . . 42 inches wide, 7 feet long—sumps 24 in. into the face to rip more coal each cycle—swings 45° to mine 22 ft. rooms. Faster tramming, up to 85 feet per minute. The most powerful, dependable, high production miner available for high seams.

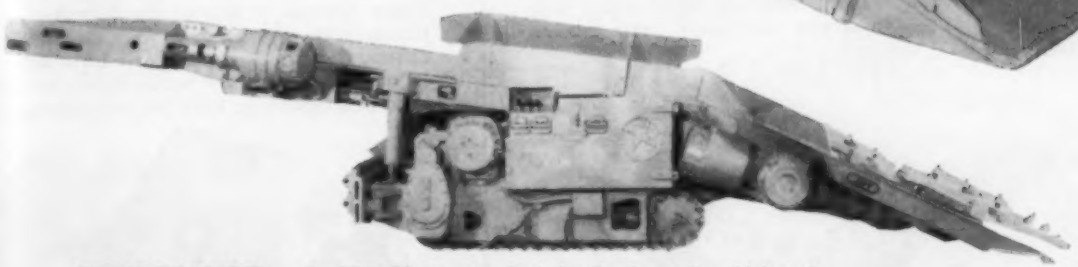
The 15-BU is available in two models: 43 inches high and 50 inches high. Both are high capacity loaders with new easy-to-service "swing out" panels. All parts requiring regular inspection, servicing or maintenance can be reached from the outside. Hydraulic pump, motor, oil tank are mounted on swing-out bumper. All motors and drives are mounted outside the frame. Electrical control panels swing open with controls mounted inside hinged cover plate.

The 16SC-4 is new from the ground up. New 53% stronger wheel units, the most advanced and rugged on the market, provide trouble-free tramming under the most brutal service.

Available in AC or DC, the 16SC-4 has 2 big traction motors, one for each side of the car. Maintenance is simple because there are no complicated transmissions, shifting clutches, or torque converters. You get four-wheel positive drive without differentials—four wheel steering without tie rods. No power is wasted in complex gearing systems, and all motors and working parts are easy to reach.

FOR MEDIUM-HIGH SEAMS

THE 6-CM CONTINUOUS MINER . . . for highest capacity in seams 5½ to 10 ft. high.



THE 15-BU LOADER . . . for 15 to 20 ton per minute loading in medium-high coal.

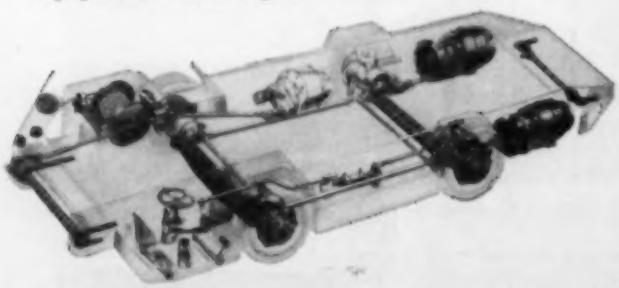
THE 16SC-4 SHUTTLE CAR . . . 33 inches high . . . 4 to 6 tons capacity.

JOY

RAMAC INVENTORY CONTROL SYSTEM . . . a newly installed electronic memory system that locates parts immediately throughout any of Joy's new parts warehouses. The system stores complete information on each of the many thousands of items stocked, and answers multiple inquiries on any of them in seconds. Joy now has ten new warehouses strategically located in the field and adequately stocked with renewal parts suited to the areas they serve. Fleets of regularly-scheduled trucks deliver the parts you need when you need them. Joy is now operating on an 85% immediate delivery basis.

Service Keeps Pace with Engineering Progress

NEW WHEEL KITS FOR JOY 5, 6 and 7SC's . . . modernize your shuttle cars. Joy now has a package conversion kit available to bring your older shuttle cars right up-to-date, for more years of service with low maintenance cost. By replacing old wheel units with new 16SC wheel units you can make your present equipment 53% stronger.



NEW HEAVY-DUTY RIPPER AND CONVEYOR CHAINS . . . Joy now has available an expanded line of ripper and conveyor chains. The new conveyor chains are stronger and last longer because of heavier flights and pins, and premium quality roller chain. The new ripper chains, CV standard pitch and LV short pitch, accommodate the new, wider shank bits developed in cooperation with bit manufacturers.

7848-B1

WORLD'S LARGEST MANUFACTURER OF UNDERGROUND MINING MACHINERY

JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

Among the Manufacturers

W. **L. Wearly** (left), president of Joy Mfg. Co., was awarded an honorary Doctor of Engineering degree by Purdue University, Lafayette, Ind. Dr. Frederick L. Hovde, Purdue president, conferred the degree on Mr. Wearly, who graduated from the university with a B. S. degree in electrical engineering in 1937. He joined Joy as a design engineer immediately upon graduation and rose through the ranks to become president in 1957. The degree is the highest honor given by the university in recognition of distinguished achievement by the recipient in the field to which he has devoted his career.

William C. Russell has been elected a vice president of Joy Mfg. Co. Mr. Russell joined Joy in 1955 as general manager of the Electrical Products Div. with headquarters in St. Louis, Mo., and will continue to hold that position also.

Russell

Wemco, Div. of Western Machinery Co., has made several changes in its General Sales Dept. **F. V. Schneider** becomes field sales manager and **D. E. Newton** headquarters sales manager. **D. L. Springston** has been named manager of coal sales and **W. H. Reck** will continue as consulting metallurgical engineer specializing in flotation problems. **D. W. Jenkinson** is the consulting metallurgical engineer handling gravity concentration problems and **J. J. Davey** has been appointed manager, Torque-Flow sales.

Springston

Holan Corp., wholly-owned subsidiary of Ohio Brass Co., has purchased Universal Hydraulics, Inc., Cleveland manufacturer of hydraulic components. Universal will operate as a subsidiary of Holan and will continue to make hydraulic cylinders and valves.

Martin B. Jaeger was named to the newly created post of advertising manager for Koehring Co. He will be responsible for directing the product advertising publicity programs for all Koehring divisions and subsidiaries.

South Bend Div. of Curtiss-Wright Corp. has announced that Aldridge Harbour Equipment Co., Inc., of Jackson, Miss., will be the distributor for Curtiss' complete line of construction machinery throughout southern Mississippi.

BELT FAILURES?

Switch to

NEW YORK RUBBER!

New York Rubber, famous since 1851, manufactures belt designed to meet trouble—and overcome it! Built for the most severe service demands, there's a New York Rubber belt designed to solve *your* problem. Mineral mining, quarrying, coal mining—these activities often require a belt that will show superior resistance to sharp and abrasive materials, frequently in the presence of oil and grease conditions. Fire, too, takes its toll of conventional belts.

That's why it will pay you to investigate New York Rubber. A brief description of four of our most popular belts follows. Write on your letterhead for more complete details on these and other superior New York Rubber Belts.

REDUCE FAILURES

with these New York Rubber belts:

STONORE—Highest quality, for most severe service. Handles heavy ores, trap rock, crushed stone, coarse broken glass, slag, cement clinkers, direct feed from digging and mining machinery. Mildew-proof.

DEPENDABLE—For handling coal both under and above ground, sand and gravel, trap rock, sulphur, lime and limestone. Ideal for sub-zero temperatures. Mildew-proof.

NEOPRENE—Resists oil and grease conditions adverse to natural rubber. Handles caustics and coal briquettes. Heat-resistant to 250°F. Mildew-proof.

TEMP-PRENE*—A neoprene compounded for fire resistance and severe, rough surfaces. Mildew-proof.

*Acceptance designation: "Fire Resistant, U.S.B.M. No. 28-14".

NY RUBBER

NEW YORK RUBBER

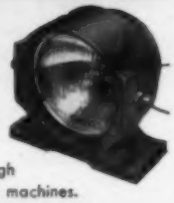
CORPORATION

Established 1851

100 PARK AVENUE • NEW YORK 17, NEW YORK

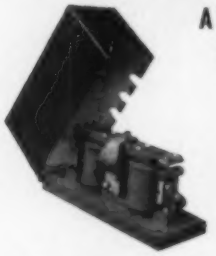
EXPECT the BEST
from all
FLOOD CITY
PRODUCTS

HEADLIGHTS
6, 32 and 115 V.



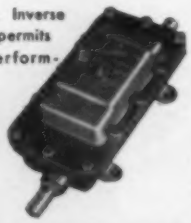
Sealed beam throws powerful light which does not dim with use. Sturdy, long life enclosure suited for rough use on mine locos and machines.

AUTOMATIC
TRANSFER
SWITCH



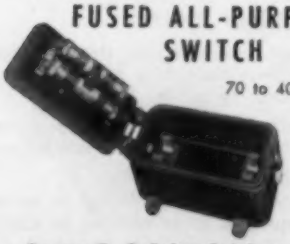
Simple, compact.. designed to perform efficiently under hard use. Completely automatic, the proper circuit is always connected to the power source, whether cable or trolley. Cover is dirt and drip-proof.

"NO-FUSE" TYPE PERMISSIBLE
STARTER



For gaseous mines. Inverse time limit element permits maximum motor performance with positive protection. In event of overload it is only necessary to move handle to "reset" position, no fuse to change.

FUSED ALL-PURPOSE
SWITCH
70 to 400 amp



For any D. C. Safety Switch application at less initial cost. Compact, sturdy, and thoroughly sealed against moisture. Also made as two circuit-junction box.

FLOOD CITY
BRASS & ELECTRIC CO.
JOHNSTOWN, PA.

CALL US FOR
PUMPS and PUMP REPAIR

Manufacturers *(Continued)*

H. J. Longmore was elected vice president in charge of sales for Sprague & Henwood, Inc. Associated with the company for over 34 yr, Mr. Longmore is known throughout the diamond core drilling industry and in the mining and construction fields. He is executive vice president of Sprague & Henwood International Corp.; vice president of Mine & Mill Supply Co.; and secretary of Rotary Drilling Equipment, Inc. All are subsidiaries of Sprague & Henwood, Inc.

Longmore

R. T. Hair has been appointed general sales manager, Coal Machinery Div., Joy Mfg. Co. Formerly sales manager of the division, he will continue to maintain his office at the firm's headquarters in Pittsburgh, Pa. Mr. Hair has been with Joy since 1943 in various positions including general service manager and product manager, miners and loaders. He helped develop the shuttle car, timber setter and other mining machines. He is a member of the American Standard Association, Coal Mining Institute of America and West Virginia Mining Institute.

Hair

William P. Yant, the first president of the American Industrial Hygiene Association at its formation in 1939, was one of the group of past presidents who were honored in special award ceremonies at the Association's 20th Annual Meeting in Chicago recently. Each received a bronze plaque in acknowledgment of his services. Dr. Yant has headed research and development activities at Mine Safety Appliances Co. since 1936.

Yant

Torit Mfg. Co. is planning to consolidate operations currently at three separate locations in one plant that will increase the firm's manufacturing facilities by about 25%. Torit makes industrial dust collectors and dental laboratory equipment.

L. D. Gent, former manager of the Pittsburgh district sales office, has been appointed sales manager, coal industry, with headquarters at the Pittsburgh office. He has been with Joy since 1943 holding various sales and service positions. A graduate of Penn State University with a BS in Mining Engineering, he is a member of AIMME and West Virginia Mining Institute. He will be succeeded as district manager by **R. M. Hippard**, a veteran of 23 yr with Joy.

Gent

Recent realignment of duties for key personnel at Goodman Mfg. Co. included the movement of **John C. Cosgrove** to managership at Pittsburgh. Mr. Cosgrove, a Penn State graduate, has been district manager at Huntington, W. Va. At Huntington, **L. W. Peterson** has been appointed to replace Mr. Cosgrove. He has been serving as manager of the firm's Birmingham, Ala., district. And to take the place of Mr. Peterson at Birmingham is **Charles D. Reese**, a Colorado School of Mines graduate, who has been affiliated with Goodman since 1948, both in the United States and Canada.

Herman H. Mesick is the new conventions manager and coordinator of national account sales for White Truck Div. of The White Motor Co. He has been with the firm since 1956.

Jones & Laughlin Steel Corp. designated sales territories for the Wire Rope Div. and appointed area sales managers. **W. H. Hickman** will be manager for the central territory with Pittsburgh headquarters. **D. D. Hyland** will handle the midwest out of Chicago. And **M. Olds** will be in charge of the northeast with home base in Muncy, Pa.

Joseph E. Adams, vice president, manufacturing for White Motor Co., was elected executive vice president, manufacturing and development. He will coordinate product research and development, manufacturing, advance engineering and purchasing in all divisions.

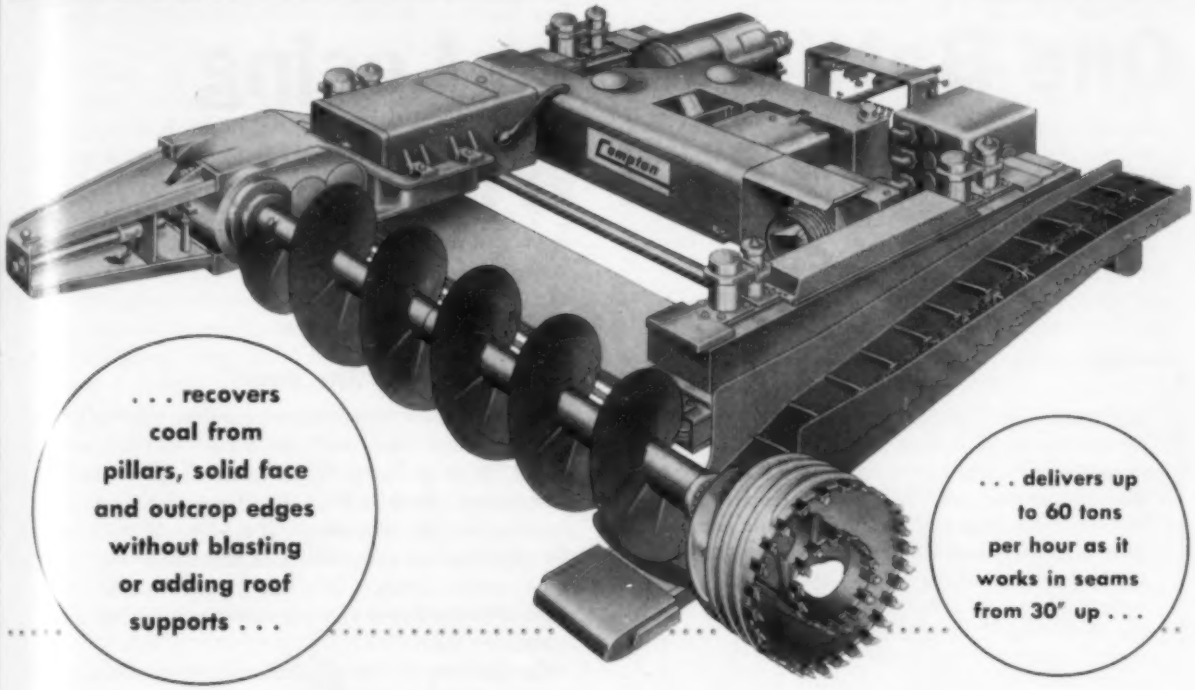
A. G. Neumayer has been appointed vibrating screen sales engineer for Syntron Co. **Edward A. Thoma** is the new vibratory feeder sales engineer for the firm.

Napco Industries, Inc., announced it has acquired the manufacturing and sales rights for Center Line Steering Axles from Transportation Engineering Components, Inc. The axles will be manufactured at Napco's Minneapolis plant.

The new Model CU-32

(U. S. Bureau of Mines Approved)

Compton Underground Auger



. . . recovers coal from pillars, solid face and outcrop edges without blasting or adding roof supports . . .

. . . delivers up to 60 tons per hour as it works in seams from 30″ up . . .

The new Compton Underground Auger, Model CU-32 (U.S. Bureau of Mines Approved) is a self-mobile, low-type machine that packs open pit augering flexibility deep down under.

It is designed for dual or single pillar boring; dual or single conveying and loading into shuttle cars or piggy-back conveyors . . . operating "solo," or "teaming up" with a continuous miner. Pays off with superiority of performance either way . . . and fast enough to pay for itself!

As a "team machine," the new Compton Underground Auger cross cuts ventilation holes, then works the coal from existing pillars, the solid face and outcrop edges without roof support and blasting, after the continuous miner moves to another section.

The Compton Underground Auger self-anchors to the roof at any height from the bottom; mobility is achieved by hydraulic walkers or optional Cat assemblies. Optional gear trains for varied auger speeds, and optional auger handling mechanism are available.

The new Compton Underground Auger, Model CU-32 is spearheaded by its patented Cutting Head which cuts 40 to 60 tons per hour in seams from 30″ up. Head, equipped with Compton Friction Bit Holders and double tapered bit shanks for fast replacement, bores 24″ to 38″ diameter holes through coal, binders, slate, jack rock, etc. at depths to 125 feet.

The new Compton Underground Auger is AC or DC powered. Operates effectively under normal conditions with a crew of three.

Compton, Inc.

ORIGINATORS OF COMPTON LUMP RECOVERY HEADS

CLARKSBURG, W. VA.

WHEN LOOKING FOR AUGERS—LOOK TO COMPTON

A MESSAGE TO AMERICAN INDUSTRY • ONE OF A SERIES

One Battle We're Losing —And Why

Lest it seem self-serving, we of McGraw-Hill, as publishers, have hesitated to make the following statement about the "Battle of the Books." However, our reticence has been overcome by our conviction that it is greatly in the national interest to have much wider public understanding of the nature of this battle. This conviction is strengthened by the fact that many, not in the publishing industry, believe in the importance of this battle and, further, by the fact that it is a battle which the United States is losing.

The United States is losing an important battle — a battle of knowledge and ideas, waged with books. It does not have the excitement of competition in scientific achievement, nor the urgency of a diplomatic crisis, nor the obvious economic significance of a struggle for export markets. But our success or failure in this battle of knowledge and ideas may well have a decisive bearing on these more spectacular aspects of international rivalry.

The Russians know this. About a decade ago, they started a program to build up their export of books, the most durable and penetrating way of communicating knowledge and ideas. **By 1957 the Soviet Union was exporting 30 million books, one-and-a half times as many as the United States.** Many of these books are printed in English, and all are in languages of the non-Communist world.

In the languages of the Near East alone, the Russians printed and distributed 413,600 books in 1957, as compared with 166,415 in 1956. In India, Russian textbooks on engineering are to be published in English under a technical aid agreement signed in Moscow last December.

"Trade Follows The Book"

Books are in the advance guard of the Soviet political and economic challenge to the free world. With books go ways of thinking — about government, about education, about management, about science and technology. If these books do their job effectively in the training of those who will become a nation's leaders, they will provide the basis for political and cultural understanding and also, in the future, for trade.

The Russians are not the first to discover this relationship. Britain, which lives by trade, has traditionally exported more of its book production than any other nation. Today it exports one book in every two produced. The British have a favorite dictum: "Trade follows the book." They have proved its accuracy. Now the Russians are trying to make this same principle serve their purposes.

Where does the United States stand in this competition for men's minds? In number of books, it trails far behind the Soviet Union — exporting roughly 20 million books, against the Russians' 30 million. As a proportion of our total output of books, our exports amount to only 10% — against Britain's 50%.

The Russians' Advantage

U.S. book exports have grown in the years since World War II, from approximately $11,000,000 in 1946 to $35,000,000 in 1958 (both figures excluding Canada). But in expanding book exports, the American publishing industry faces two major obstacles:

(1) **The comparatively high cost of producing a book in the United States,** which puts its price well beyond the reach of many students, teachers and businessmen in other countries; and

(2) **The shortage of dollar exchange in many countries,** which means that importers can pay for

books only in currencies that are of little use to American publishers.

The Russians have neither of these problems. Soviet publishing is state-subsidized, and exported books are sold for nominal sums paid in the currencies of the importers. As these books serve the political and economic purposes of the Soviet Union, they are cheerfully sold on giveaway terms.

The American publishing industry, on its own, is making vigorous efforts to increase the distribution of American books in other countries. Leading U.S. publishers and their agents have offices and salesmen in the major countries of Asia, Africa and Latin America. Several publishers have begun to reprint textbooks in Asia at one-half to one-third of their U.S. costs, thus making them available to the students in Asian countries at prices they can more nearly afford. And the American paperback has become a symbol of low cost in popular books. But neither of these devices is practicable for serious cultural, technical, scientific, educational and professional books, which require durable, hard-bound and necessarily expensive editions. Despite their great importance to those who need these books, the demand for them is simply not large enough to warrant low-cost publishing methods.

Government agencies also have increased the availability of American books. The United States Information Agency and the International Cooperation Administration have placed American books in libraries overseas, donated them to educational institutions and presented them to key individuals in the industries and governments of the developing countries of the world. But these programs are small in relation to the need.

A Modest Program

An unusual and little-publicized Government program has helped American publishers overcome the other major obstacle to the export of books — the shortage of dollar exchange. This is the Informational Media Guaranty (IMG) program, administered by the United States Information Agency. It enables publishers of books judged to be worthy of the American way of life to sell their books, for local currency, in countries such as the Philippines, Formosa, Vietnam, Burma, Indonesia, Pakistan, Turkey, Israel, Poland, Yugoslavia, Spain and Chile, which would otherwise be unable to buy these books because of their shortage of U.S. dollar exchange.

The IMG program is not a giveaway. Publishers have to **sell** their books, and customers overseas have to want them enough to **buy** them at full prices. IMG merely guarantees that the exporting publisher receives in dollars the payments he collects from his customers in their currency. The program costs very little in terms of our total foreign aid program, or in terms of what it accomplishes. In ten years it has made possible the sale of $150 million worth of books, magazines and films to countries of key economic and strategic importance at a cost of only $10 million.

The IMG functions through a revolving fund. Foreign currencies are exchanged for dollars, and the foreign currencies in turn are resold to replenish the supply of dollars. The net cost is the small but unavoidable loss on resale of these foreign currencies. Over the ten years of this program, the IMG revolving fund has shrunk from its original $28 million to $18 million, $10 million of which is in unconverted foreign currencies.

If this modest but vitally important program is to be continued, Congress must appropriate the money necessary to rebuild the revolving fund. This would ensure that any country approved by the State Department and willing to sign an agreement to buy American books, at their full price, with its own currency, could do so. Last August, Congress reduced a requested appropriation for this purpose from $7 million to $2½ million. To continue even at its present reduced level, an appropriation of $3½ million is needed. To realize the full potential of IMG, the revolving fund must be restored to its original level.

If the IMG program is not continued, with adequate financial support, some countries whose friendship and understanding we seek today and with whom we hope to build a trading partnership in the future will have to reduce their purchases of American books to a trickle. These are countries where school teachers, college professors, students, engineers, doctors and businessmen need and want to buy American books. The loss will be not only theirs, but ours as well. For it will deprive the U.S. of one of its most effective, and least costly, means of communicating knowledge and ideas and understanding of the American way of life.

This message is presented by the McGraw-Hill Publishing Company to help increase public knowledge and understanding of an important national problem. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C. McGraw

PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

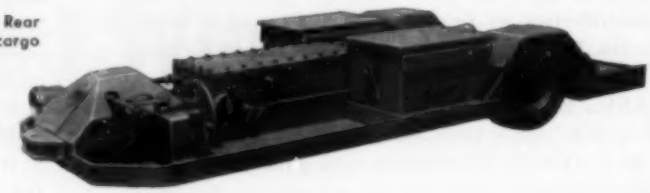
KERSEY

RUBBER-TIRED AND RAIL SUPPLY AND PERSONNEL SYSTEMS FOR LARGE MINES

Specially designed, ruggedly built equipment that provides maximum in safety—maximum in time-saving.

PPC-9 PERMISSIBLE, PERSONNEL, SUPPLY AND SERVICE TRACTOR

Used as mechanics car, supply truck or emergency vehicle. Rear cargo deck will accommodate stretcher. Detachable rear cargo compartment has 2,000 lb. capacity.



Special Features

12 K. W. H., 40 cell, Permissible Motive-Power Type Battery.

Hydraulic — Airplane Disc Type Brakes.

Magnetic type contactor in permissible enclosure; two speeds — forward and reverse.

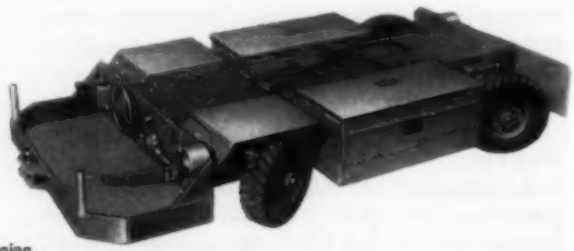
2,300 lb. draw bar pull for starting.

6-½ H. P. series-wound, heavy-duty Gearmotor in permissible enclosure.

MODEL 944 HEAVY DUTY, 4-WHEEL DRIVE, 4-WHEEL STEER AND 4-WHEEL BRAKE TRACTOR

For heavy loads . . . Long hauls.

Weighing 9,200 lbs. this Super Duty 20 H. P. tractor with Pow'r Lok axle assemblies assures positive 4-wheel traction for moving heavy machinery, or pulling a train of supply or man trip cars.



Special Features

Front and rear axle assemblies mounted on coil springs for better traction.

Pow'r Lok Differentials (when one wheel slips, differential locks and both wheels pull to prevent losing traction.)

48 Motive-Power Type Battery with 280 A. H. capacity.

3-speed magnetic contactor control system with interlocks to prevent plugging.

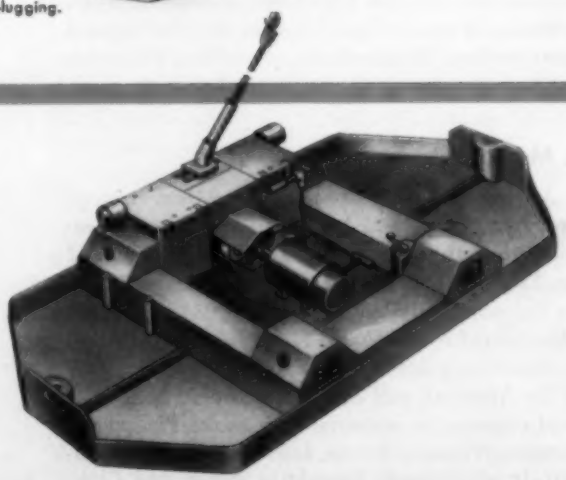
6,100 lb. draw bar pull for starting.

Standard 20 H. P. series-wound motor.

RMT RAIL TYPE SERVICE TRUCK

Utility Vehicle For Mechanics, Electricians, Officials.

This heavy duty utility truck with 1,000 lb. cargo deck on each end can be used by the construction gang to move men and materials, by the mechanics and electricians for their tools, parts, and motors, and by bosses and inspectors to travel about the mine.



Special Features

Length 12'; Width 72"; Weight 4,000 lbs.

7-½ H. P. (W) "Life Line H" Motor, compound wound.

4-speed reversing Controller.

3" Ryax steel axles.

15" cast iron wheels.

Disc Type Hydraulic Service Brake.

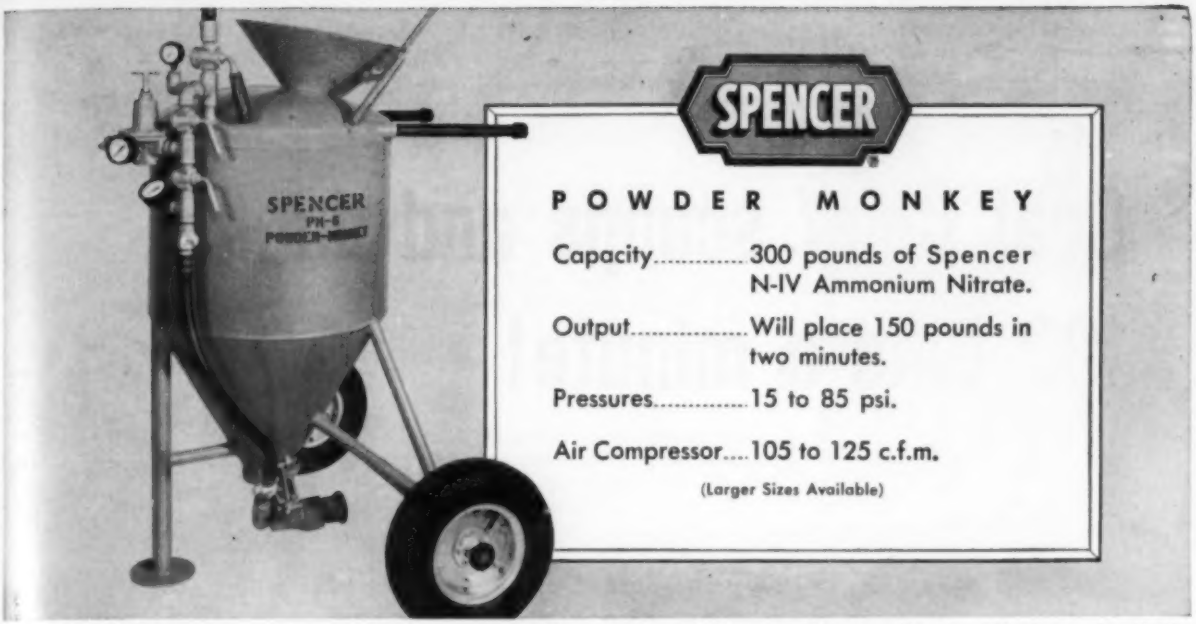
Two 8" Band Type Parking Brakes.

KERSEY MANUFACTURING CO. INC. BLUEFIELD, VIRGINIA

ADDITIONAL PRODUCTS AND EQUIPMENT

Model 744, Rubber-Tire 4-wheel drive, steer & brakes.
Model HT-8, Rubber-Tire 2-wheel drive.
Model 444, Rubber-Tire 4-wheel drive, steer & brakes.
230v, AC, Single-Phase, Model TD-AC-1, Self-Propelled Coal Cutting Machine.
Complete line of Batteries & Battery Chargers.
Shuttle Cars, Battery or Cable, Drop Bottom or Conveyor Types.

If you are starting a new mine or modernizing your present mine check with us, first.



One man is all it takes to fill horizontal holes with Spencer N-IV Ammonium Nitrate for blasting, when you use the new Spencer Powder Monkey. Available with wheels for towing, or mount on powder truck.

At Last! A Machine For Fast, Easy Placement Of Ammonium Nitrate In Horizontal Blast Holes:

New Spencer Powder Monkey saves you $3.00 to $4.00 per 100 pounds on bag costs alone!

Scientifically designed for placement of Spencer N-IV Ammonium Nitrate in horizontal blast holes, the Spencer Powder Monkey *blows* the prills into the hole. Then the Powder Monkey is filled with sand, which is blown into the holes for stemming.

There's no need for tamping bags, tamping equipment, or the labor needed to fill and tamp bags into the hole!

With the Powder Monkey, you can actually load faster and more economically than with any other known method! Job-tested on holes ranging from 1⅝ inches to 8 inches in diameter, the Powder Monkey has proved itself under a wide variety of conditions.

Another advantage of placing Spencer N-IV with the Powder Monkey is that you can prime the entire charge with detonating cord at the same time you insert the hose in the blast hole for filling.

World's Most Efficient Low-Cost Explosive

Spencer N-IV Ammonium Nitrate produces a superior blast for two reasons: (1) Spencer N-IV has a special structure that lets the prills absorb oil more easily. (2) Spencer N-IV contains a much higher percentage of ammonium nitrate than other brands.

Because of these two advantages, Spencer N-IV produces more energy than competitive grades of ammonium nitrate, yet costs no more!

How N-IV Reduces Priming Costs

With Spencer N-IV, you save on priming costs, too, because it can be initiated with a single strand of 175-grain detonating cord. And you put an end to the danger of storing high explosives on the job site!

Spencer N-IV is available in all-plastic 50-pound bags that are tougher than paper—so tough they reduce breakage as much as 50%. They are so weather-proof you can store them right out in the open! (Also available in paper bags.)

For more information on Spencer N-IV Ammonium Nitrate, or the new Spencer Powder Monkey, tear off and mail the coupon below:

SPENCER

Spencer Chemical Company
401 Dwight Building
Kansas City 5, Missouri

Yes! I want to know more about:

☐ Spencer Powder Monkey
☐ Spencer N-IV Ammonium Nitrate

Please rush information!

Name_____

Firm_____

Address_____

City_____ State_____

Coal Chief scoops and dumps 100 tons a minute!

Four Boom Support Strands, each 3⅝" dia., support the huge boom which towers 160 feet above the ground. These Tiger Brand cables are designed for long service life.

USS American Tiger Brand Hoist Rope. Two of these 2⅝" dia. shovel hoist ropes supply the guts to lift the heaviest loads.

Rigged with USS Tiger Brand – America's No.1 Wire Rope

Here's the latest of the big diggers, the Coal Chief, built by Marion Power Shovel Company. It can scoop up 70 cubic yards at a bite, swing it approximately the length of a football field and dump it in piles more than 96 feet high. It makes the round trip in less than 60 seconds.

This strip mining operation is a joint venture between Simco Peabody Company and Columbus & Southern Power, Columbus, Ohio. All the coal produced will be furnished to the power company . . . about 8,000 tons a day.

The new shovel, like its two predecessors, is rigged throughout with USS American Tiger Brand Wire Rope. The tremendous power of the shovel is handled by two hoist ropes 2⅝" diameter, and the gigantic boom is supported by four lengths each 105½ feet long, of 3⅝" diameter galvanized boom support strand. Each strand has a catalog strength of 768 tons, for a total of 3,072 tons.

Your equipment may not need such large wire rope, but the fact that all applications on this huge shovel are handled by standard USS American Tiger Brand constructions emphasizes the quality of the engineering that goes into the complete line of Tiger Brand Wire Rope. For information, write American Steel & Wire, 614 Superior Ave., N.W., Cleveland 13, Ohio.

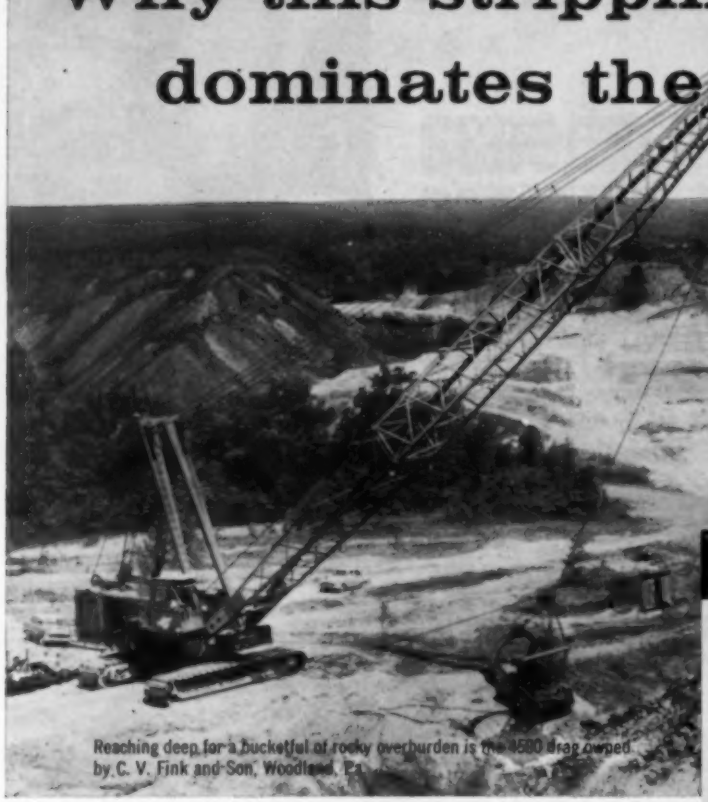
USS, American and Tiger Brand are registered trademarks

American Steel & Wire Division of USS United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors
United States Steel Export Company, Distributors Abroad

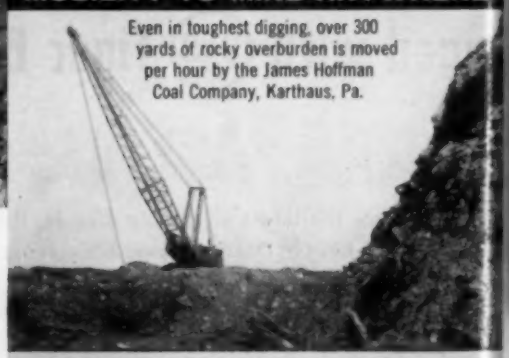
6,000 tons of overburden per hour can be stripped by this new 70-cubic-yard Marion shovel built for Simco Peabody Company and Columbus & Southern Power.

Why this stripping "favorite" dominates the strip mines



Reaching deep for a bucketful of rocky overburden is the 4500 drag owned by C. V. Fink and Son, Woodland, Pa.

DIESEL POWERED WITH THE MOBILITY TO MINE ANYWHERE



Even in toughest digging, over 300 yards of rocky overburden is moved per hour by the James Hoffman Coal Company, Karthaus, Pa.

This Manitowoc 4500 shovel produces big output at lowest cost, shift after shift.

The Black Tam Mining Company in Wheatcroft, Ky. moves rock-strewn overburden with a fast-cycling 4500 dragline.

Many of the strip mines in your area have settled on the powerful Manitowoc 4500 as their basic stripping tool.

It's easy to see the reason for this preference. The 4500 gives you advantages found in no other unit. You get a big 6-yard capacity diesel powered unit with the mobility of a "small machine" to mine scattered or large areas inaccessible to electric machines. You get far more simple, dependable design, with exclusive "Power Flo" drive; torque converter that matches power to the job; air controls; faster operating cycles; and heavy, rugged construction throughout for the toughest jobs.

Special hi-lift shovel booms and strong, lightweight drag booms provide the reach to throw spoil far from the cut — make more passes from one location. The exceptionally low ground bearing pressure of wide-span, extra long, self-cleaning crawlers lets you work right at the edge of the cut where you have maximum reach and best working visibility.

If you're interested in faster, more economical strip mining, you'll want more information from your helpful Manitowoc distributor. See him soon. And ask him for a copy of the informative booklet — "More Economical Coal Mining with Manitowoc" — no obligation, of course.

MANITOWOC ENGINEERING CORP.

(A subsidiary of The Manitowoc Company, Inc.)

MANITOWOC, WIS.

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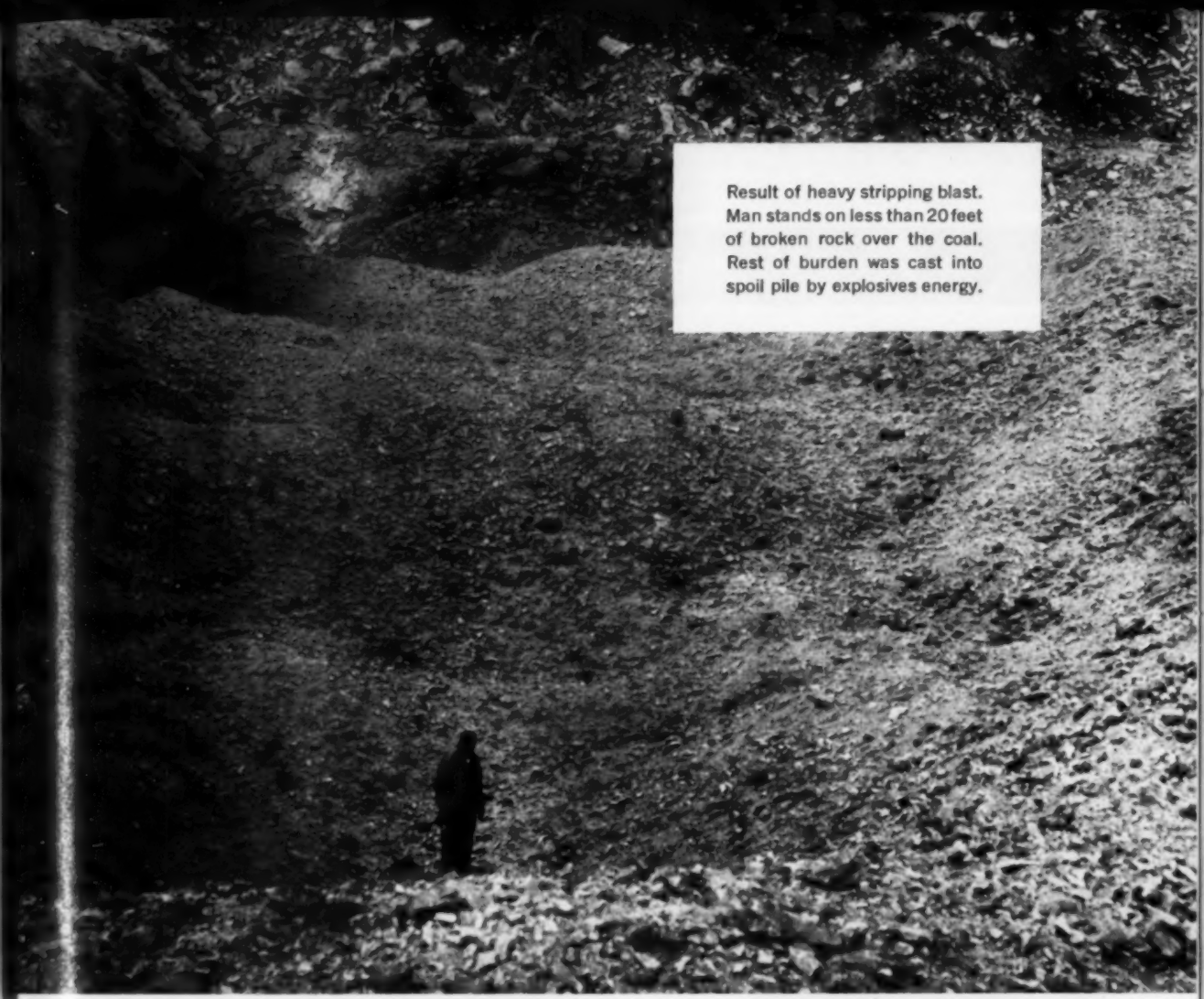
SHOVELS AND DRAGLINES 1¼ to 6 Yds.



Result of heavy stripping blast. Man stands on less than 20 feet of broken rock over the coal. Rest of burden was cast into spoil pile by explosives energy.

AN OPEN LETTER TO THE COAL STRIPPING INDUSTRY

"Explosives are the cheapest labor you can hire."

Sometimes that's a hard statement to prove, but with the use of low cost blasting agents, it's making more sense every day.

Latest development is in northwest Pennsylvania where certain stripping operators are *proving* that, under their conditions, explosives energy is cheaper than mechanical energy in moving overburden to the spoil pile. Even though they are using 2½ to 3 times the explosives normally fired, they are saving money . . . so much they wouldn't consider going back to older methods.

Formerly, they had used about 1 lb. of blasting agent to break 2½ to 3 cubic yards of rock. The formation was dislodged from the strata, then dug conventionally with the dragline sitting atop the shot bank.

With the new method, the overburden is loaded so heavy —over 1 lb. of blasting agent per cubic yard of overburden—that up to 40% is blown across the pit to the spoil area. Remaining overburden is spread across the pit at ⅓ to ½ the height of the original bank. Following the shot, a bulldozer smooths the top of the pile, and the dragline walks out on top of the shot material.

Although some had to see it to be convinced, all three operators agree they uncover 30% more coal in a given length of time . . . that overburden is broken much better, resulting in less down time for the dragline, and considerably longer cable life. Bulldozer time for reclamation is reduced 20%.

This is another example of how modern methods are helping cut costs. Let the Atlas representative in your area discuss this new technique with you to see if it can be applied to your conditions.

EXPLOSIVES DIVISION
ATLAS POWDER COMPANY
WILMINGTON 99, DELAWARE
Offices in principal cities

HIGH VOLTAGE

Rome 60 mine power cable represents the ultimate in safe design of a nonmetallic-jacketed cable. Coated copper conductors are covered with a semi-conducting tape and insulated with an ozone-resistant Rozone (oil-base) insulation compound. Rozone insulation is designed to stand up under continuous use at 75 C. Each insulated conductor is covered with a color-coded semi-conducting tape, for phase identification, and shielded throughout its entire length with a metallic shielding tape. Entire construction is covered with a reinforced Roprene (neoprene) jacket, highly resistant to acids, alkalies, oils, abrasion and flame.

Rome Type MPT mine power and feeder cable is an economical and easy-to-handle nonmetallic-jacketed power cable for mine feeder and industrial service. Insulated with polyethylene and jacketed with Roseal (flame-retardant polyethylene), it is less expensive, lighter in weight and smaller in diameter than conventional rubber and neoprene types. The insulating compound and jacket give superior resistance to most chemicals, moisture, mechanical damage and wear—important advantages for mining applications! Special construction provides long life and safety: individual conductors are strand shielded; Rolene (polyethylene) insulation on each conductor is shielded.

Rome 60 Type SH-D shielded portable power cable is designed for high-voltage operation, for use on shovels, dredges, mining machines and other similar rugged-service applications. This cable consists of 3 or 4 conductors insulated with Rozone, a high-grade ozone-resistant oil-base compound, or Rozone A butyl-base compound. A semi-conducting tape is applied over the copper conductors. The insulated conductors are covered with a color-coded tape for circuit identification. A flexible shielding braid is applied over each insulated and taped conductor, and the assembly is then covered with a reinforced jacket of mold-vulcanized neoprene (Roprene).

Before you buy another foot of mining cable, check . . .

Rome's guide to selecting any job in your mine

LOW VOLTAGE

Rome 60 Type W portable power cable is a round multiple-conductor made up with the specified number of flexible, color-coded insulated conductors cabled together and protected by a reinforced sheath of neoprene. This heavy-duty multiconductor portable power cable is particularly recommended for use on electric shovels, loaders, mucking machines and other equipment where delivery of a heavy power load is required. The specially compounded neoprene jacket is molded in lead to a tirelike toughness and is highly resistant to acids, alkalies, oils, abrasion and flame.

Rome 60 Type G portable power cable is similar in construction to Type W cable (see above) except that grounding conductors are placed in the interstices of the cable assembly. As with Type W and with flat twin cables, each length carries the symbol "P-105 BM" denoting compliance with Federal and Pennsylvania safety codes. All Rome 60 mining cables are insulated with a special heat-resistant rubber compound suitable for operation at 75 C., thereby providing extra overload protection. Both Type G and Type W portable power cables are available with two, three and four conductors for up to 600-volt use.

Rome 60 Flat Twin (parallel duplex) mining machine cable, for shuttle car service, features a neoprene webbing between power and grounding conductors which, unlike fibrous components, cannot rot, deteriorate or absorb moisture. The resiliency of neoprene, compared with fibrous materials, provides higher impact resistance, as well as increased protection against short circuits. Flat Twin Type W cable, without grounding conductor, is used on track-mounted equipment in ungrounded systems. Flat Twin Type G cable, with grounding conductor, is used for portable and rubber-tired equipment where grounding is required. These cables are relatively small in diameter, flexible, easy to handle and offer maximum resistance to physical abuse. Use for up to 600 volts.

Get more details with this coupon!

cable for

ROME CABLE Department 15, Rome, New York

Please send more information on:

☐ Low-voltage cable ☐ High-voltage cable

☐ I want to "Meet the Man" who can tell me more.

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WHO'S DEDICATED TO YOUR JOB

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Company.....

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City..... Zone..... State.....

ROME CABLE

CORPORATION

A NEW PLANT

...for BELL & ZOLLER COAL COMPANY

Designed, Engineered and Built by

Roberts & Schaefer

Bell & Zoller chose Roberts & Schaefer to build their new plant for the same reasons it will pay you to do so. You'll find at R&S an understanding appraisal of your problem, long experience and an outstanding record of performance. You can depend on R&S for complete design and engineering services, and efficient facilities for installation and construction. Perhaps, most important of all, you'll have the comfortable feeling that, with Roberts & Schaefer on the job, you can be sure you'll get a plant with the capacity, flexibility, efficiency and economy of operation you want.

ENGINEERS & CONTRACTORS

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201 NORTH WELLS STREET, CHICAGO 6, ILLINOIS

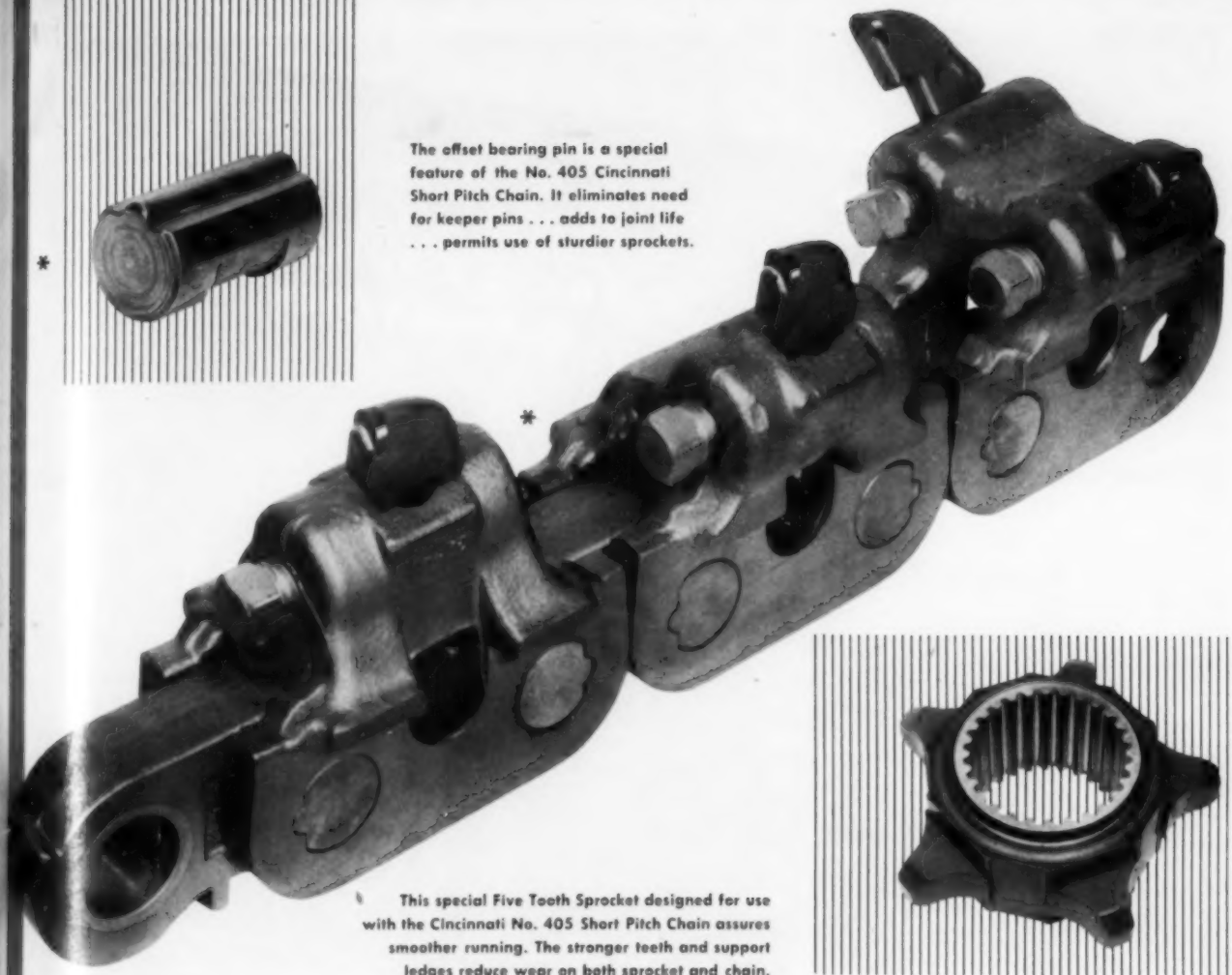
NEW YORK 10, N.Y. • PITTSBURGH 22, PA. • HUNTINGTON 10, W. VA. • ST. PAUL 1, MINN.

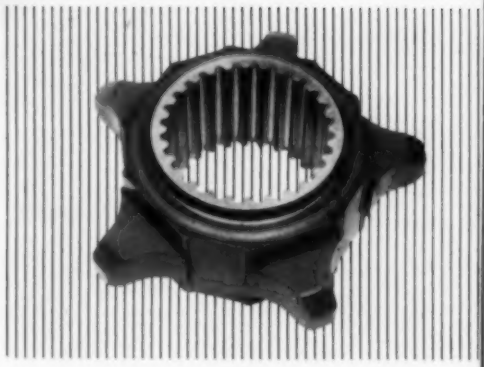
THE NEW BELL & ZOLLER ZEIGLER NO. 3 MINE

Bell & Zoller's 3-way washing and processing plant, at Zeigler No. 3 mine in Southern Illinois, combines three distinct coal cleaning methods in a single installation: Roberts & Schaefer Dutch State Mines Heavy Medium Washer, R&S Air Flow Cleaner, and Baum Jig Washer. As a result, the entire output of the mine will be processed through the new plant, delivering Zeigler coal as a more thoroughly cleaned product in all sizes and consists.

It pays to talk with Roberts & Schaefer

The offset bearing pin is a special feature of the No. 405 Cincinnati Short Pitch Chain. It eliminates need for keeper pins . . . adds to joint life . . . permits use of sturdier sprockets.





This special Five Tooth Sprocket designed for use with the Cincinnati No. 405 Short Pitch Chain assures smoother running. The stronger teeth and support ledges reduce wear on both sprocket and chain.

Breaking All Production Records with

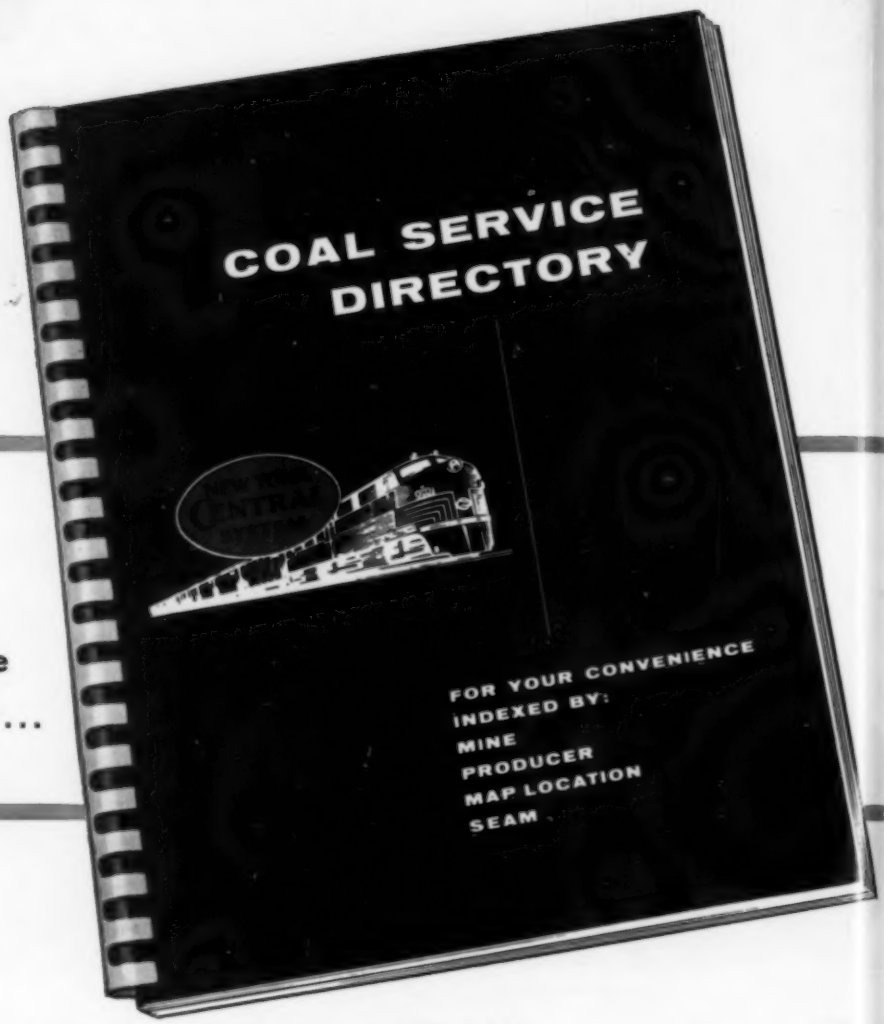
CINCINNATI'S New Short Pitch Chain

THE CINCINNATI SHORT PITCH CHAIN for use on CONTINUOUS MINERS incorporates all the features that have made Cincinnati Cutterchains world famous. Here's a short pitch chain that makes it possible to utilize a bearing pin of maximum diameter without sacrificing sprocket tooth space, strength of pin or block, or diminishing the area of any wearing surface. The FIVE TOOTH SPROCKET designed for use with the No. 405 Short Pitch Cincinnati Chain provides shelves at the base of each sprocket tooth to absorb inward thrust and prevent the tilting of the chains due to unequal side pressures. The combination of CINCINNATI'S offset bearing pin and five tooth sprocket assures you the finest operating short pitch chain obtainable.

THE CINCINNATI MINE MACHINERY CO.
Cincinnati 25, Ohio

* PATENT PENDING

Specialists in cutting equipment for over 35 years



A wealth of information for you from the New York Central...

New Coal Service Directory

Here's another example of how New York Central's technically trained Coal Sales Department staff can help coal users.

If you use or contemplate using coal, you will be interested in the factual information included in this new Coal Service Directory.

Never before has so much basic data on mines, producers, seams, map locations been assembled under a single cover for the twelve major coal-producing areas located along the New York Central lines.

This new guide quickly identifies and locates any source or type of coal needed by name of mine and/or producing company. An individual map for each of the coal-producing areas features a handy grid reference system which helps you locate any mine at a glance! Each of these maps is followed by a brief description of the coals produced in the area, including characteristics and uses for which they are most suitable.

New York Central's Coal Sales Managers are always on call to help you get the most for your coal dollar.

For assistance or for information about the new Coal Service Directory, call or write your nearest New York Central Coal Sales Department representative.

NEW YORK CENTRAL SYSTEM'S
COAL SALES DEPARTMENT

Director of Coal Sales—
H. L. Willard . . New York

Fuel Engineer—
H. A. Kiester . . New York

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New York Central Railroad

This dipper sees its dentist just twice a year

Because its teeth are two-part Amsco®"Simplex". Once, another brand of teeth was used on this 3-yard Amsco welded dipper at Vigus Quarries Inc., in Robertson, Mo. The constant smashing (9-hour, 5-day week) into jagged limestone material wore them into replacement in 6 to 8 weeks. The first set of standard design Amsco Simplex teeth was in service from May 20, 1958 through October 31, 1958 *—twenty-four weeks!*

Says Fred Weber, Jr., vice president of Vigus Quarries Inc., "The Simplex record speaks for itself . . . 3 to 4 times longer service. Now we've got Simplex points on all three of our machines and the saving is considerable."

Amsco Simplex's special alloy reversible tips are the answer to your dipper's high "dentist" bills. We'll be glad to send you a booklet containing reports by Simplex users and describing Simplex teeth completely. Write for it today.

AMERICAN Brake Shoe COMPANY AMSCO

American Manganese Steel Division
Chicago Heights, Illinois

Now SKF has improved the spherical roller bearing it invented!

This new spherical roller bearing offers even higher capacity than SKF's original, self-aligning bearing – and meets the needs of today's faster, more productive machinery. In some cases, the increase in capacity is as much as 54% – corresponding to more than 4 times longer service life!

Here's how these improvements have been obtained:

1. Eliminating undercuts and integral flanges – helps provide space for larger rollers and longer effective contact between rollers and races.

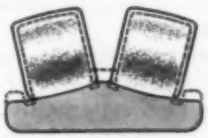

Fig. 1

Fig. 2

2. Using symmetrical rollers, unrestricted by flanges – ensures uniform load distribution over the roller length at all times, even under heavy thrust load.

3. Using an axially floating guide ring – provides effective roller guiding, and minimizes friction at roller ends.

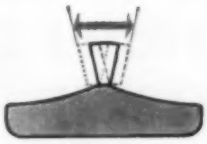

Fig. 3

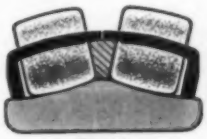

Fig. 4

4. Using a strong "window-type" cage for each row of rollers—helps ensure dependable operation over a full range of loads and speeds.

5. Placing a lubricant duct in the center of the outer ring—helps channel lubricants directly to the rollers and push contaminants away.

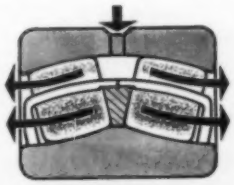

Fig. 5

For full details on this new high-capacity spherical roller bearing call the nearest SKF sales office or authorized SKF distributor listed in the yellow pages of the telephone book.

5931

Spherical, Cylindrical, Ball, and "Tyson" Tapered Roller Bearings

EVERY TYPE—EVERY USE

SKF®

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

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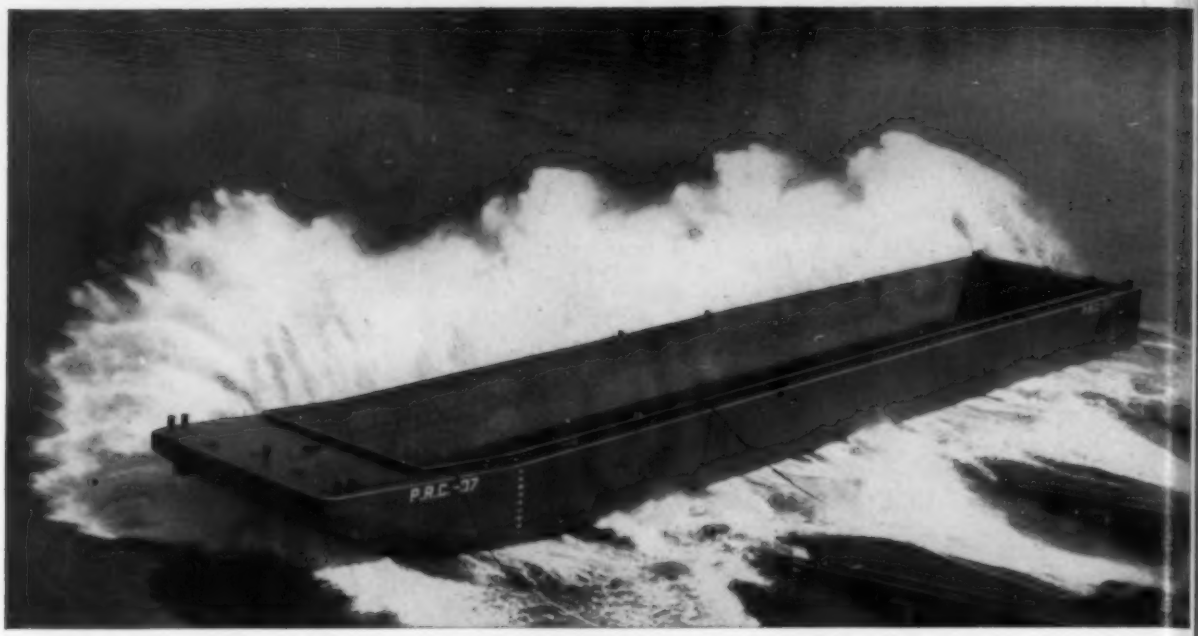


Now! Dravo offers immediate delivery on open or covered hopper barges

SPECIAL STOCK BARGE PROGRAM FEATURES DRAVO QUALITY, EARLY DELIVERY DATES

Dravo's major stock barge building program makes *now* an ideal time to invest in high quality, competitively priced, open or covered hopper barges.

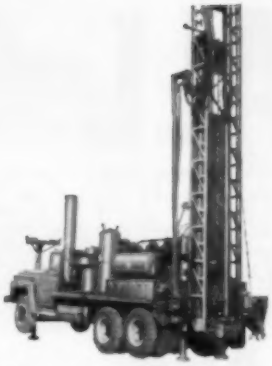
Because of this program, Dravo now has 195′ x 35′ x 11′ barges for almost immediate delivery.

Backed by Dravo construction know-how acquired in building more than 3,800 hulls, and model basin-tested for the best possible towing characteristics, these barges —now—can make a valuable addition to your fleet.

For full information, telephone, wire, or write Marine Sales Department, Dravo Corporation, Neville Island, Pittsburgh 25, Pa. SPalding 1-1200.

DRAVO
CORPORATION

Pneumatractor Mounted Rotadrill—125 cfm rotary drill rig. Hole sizes—up to 4½". Also 250 cfm model with hole sizes to 6".



Truck Mounted Rotadrill—400 cfm self-propelled rotary drill rig. Hole sizes up to 6½".

Crawler Mounted Rotadrill—diesel or electric, 600 cfm rotary drill rig. Hole sizes up to 8".

SAVE on initial cost . . . operating expense . . .

with Schramm Air Compressors and Rotary Drilling Equipment

Any mining operation can save dollars . . . increase profits . . . by using efficient, dependable Schramm air compressors, Pneumatractors and Rotadrills and drilling equipment.

Why? Two reasons: First—Schramm offers lower initial cost on practically every piece of equipment—without sacrificing quality.

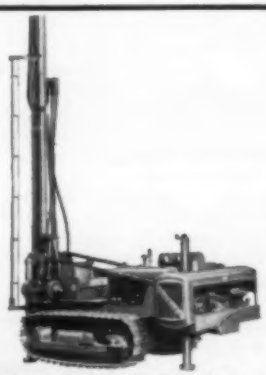
(Example: The Crawler Rotadrill costs almost $20,000 less than comparable units . . . yet is more rugged, more effective.)

Second—Schramm costs are lower in operation *and* maintenance.

(Example: Schramm Rotary Drill rigs provide the most economical drilling patterns because of their extremely fast penetration rates and larger hole sizes.)

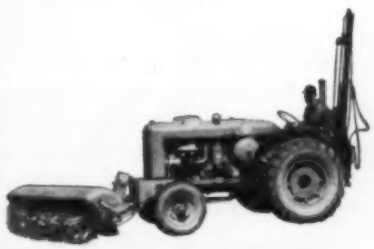
Get *all* the facts, today! Send coupon for full information.

Rotatool—fast-penetrating percussion tool increases drilling rates by producing maximum fracturing action at the bottom of the hole.

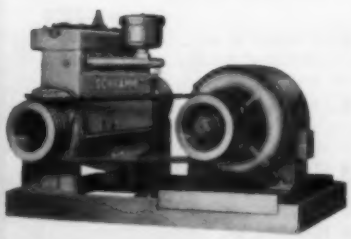


Crawler-Mounted Do-it-yourself Kit—Your own D-6, D-8, TD-14 or larger crawler tractor provides vehicle for this Rotadrill package.

Truck-Mounted Do-it-yourself Kit—complete Rotadrill package mounts on your own truck—saves vehicle cost. Hole sizes up to 6".



Self-propelled Compressors—Models 125 & 250 Pneumatractors—one man drives and operates. Wide range of accessories.



Stationary Compressors—electric motor or V-belt drive. Vibrationless operation—no foundation needed. 50 to 600 cfm.

Portable Compressors—Models from 20 cfm to 600 cfm. Economical, dependable, deliver full rated capacity at 100 psi.

Please send full data on:

- ☐ Truck Mounted Rotadrill
- ☐ Crawler Rotadrill
- ☐ Pneumatractor Rotadrill
- ☐ Do-it-yourself Rotadrill
- ☐ Rotatool
- ☐ Standard Pneumatractor
- ☐ Heavy Pneumatractor
- ☐ Portable Compressors
- ☐ Stationary Compressors
- ☐ Schramm Air Tools

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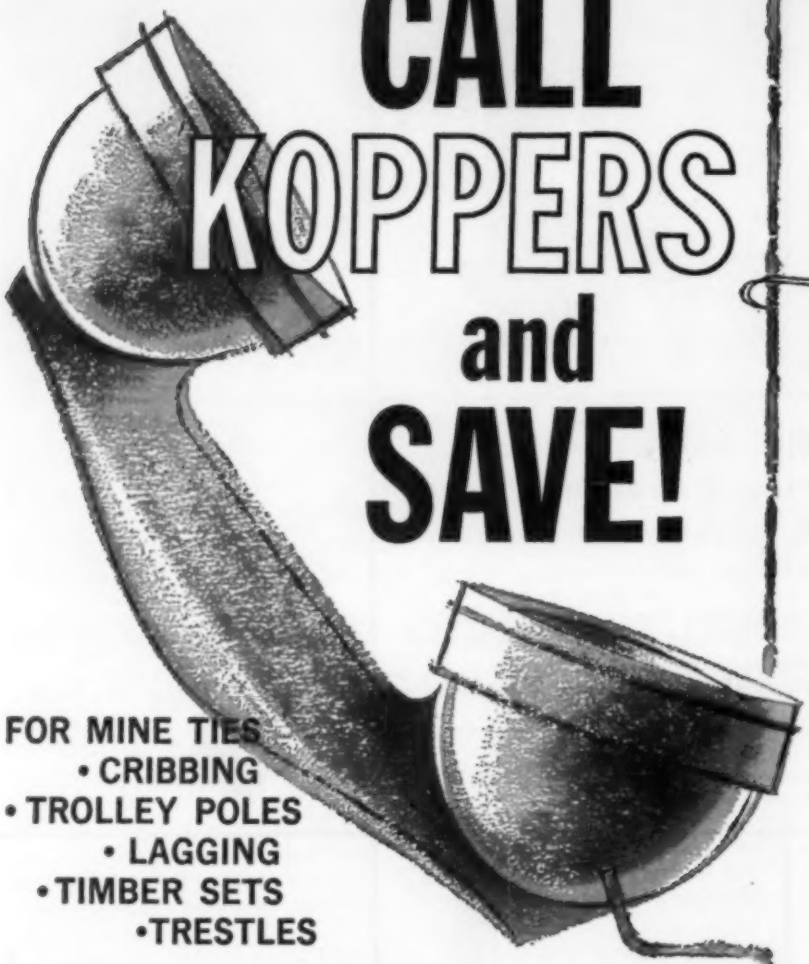
MANUFACTURERS OF AIR COMPRESSORS

733 North Garfield Ave. • West Chester, Pa.

CALL KOPPERS and SAVE!



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• CRIBBING
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• LAGGING
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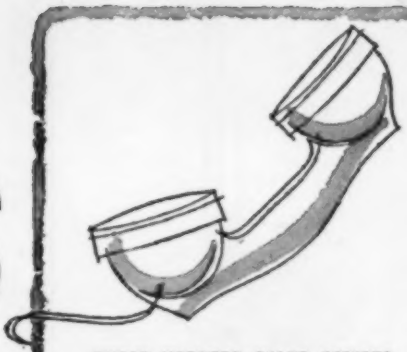
Pressure-treated wood saves mine operators money because it provides built-in protection against decay and termite attack. Pressure-treated mine ties, timbers, trolley poles, trestles and other wood support members retain their strength and last 4 to 5 times longer than untreated material. Maintenance and replacement costs are reduced and "down time" virtually eliminated.

Treated wood retains its strength and lasts longer because Koppers treating process forces creosote or Wolman® salts deep into the wood *under pressure* to give thorough, lasting protection against decay and termites. Be sure to specify Koppers pressure-treatment wherever wood must serve under severe conditions.

For product information or prices, PHONE your nearest Koppers Sales Office, or write to:

Wood Preserving Division
KOPPERS COMPANY, INC. C-39
760 Koppers Bldg., Pittsburgh 19, Pa.

KOPPERS
PRESSURE-TREATED
WOOD



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• ALEXANDRIA 7, LA., P. O. Box 1926	2-5733
• BALTIMORE 1, MD., 812 Fidelity Bldg.	Lexington 9-1786
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• CHICAGO 3, ILL., 122 S. Michigan Avenue	Webster 9-2400
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• HOUSTON 14, TEXAS, 1919 Collingsworth St.	Capital 7-6237
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• KANSAS CITY 29, MO., P. O. Box 8507, Leeds Station	Wabash 1-8060
• LOS ANGELES 17, CALIF., 1118 Wilshire Blvd.	Huntley 2-2852
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• MONTGOMERY 2, ALABAMA, P. O. Box 510	Amherst 3-3416
• NASHUA, N. HAMPSHIRE, P. O. Box 516	Tu 3-5335
• NEWPORT, DELAWARE, P. O. Box 3128	Wyman 8-8861
• NEW YORK 22, NEW YORK, 430 Park Avenue	Plaza 5-2810
• PHILADELPHIA, PA., 355-E Lancaster Ave., Haverford, Pa.	Midway 2-5853
• PITTSBURGH 19, PA., 615 Porter Building	Express 1-3300
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• SAN FRANCISCO 5, CALIF., 55 New Montgomery St.	Douglas 2-2985
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Serving industry with steels that fit the job

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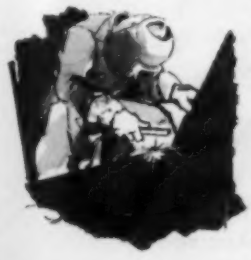
WITH LUKENS "T-1" STEEL
TRADEMARK

Where the going gets rough, versatile Lukens "T-1" steel fights back. For repair or modification of heavy duty equipment such as truck beds, chutes, bucket teeth and dozer blades, this special duty steel plate can be ordered from *warehouse stock* in a wide range of plate sizes and gages. Lukens "T-1" is the modern mining steel—you can work and weld it in the field as readily as in your shop. Its terrific resistance to abrasive impact—coupled with an extremely high yield strength—means fewer replacements and often greater payloads. That's why more and more equipment builders are using Lukens "T-1" to provide longer life in shovel buckets, trucks and other mining equipment. Remember to specify the extra-tough 321 min. BHN quality. For performance and application details, request our special booklet, "Lukens 'T-1' for Toughness." Address Manager, Application Engineering Dept., M79 Services Bldg., Lukens Steel Company, Coatesville, Pennsylvania.



These warehouses can supply you with Lukens "T-1" steel plate...

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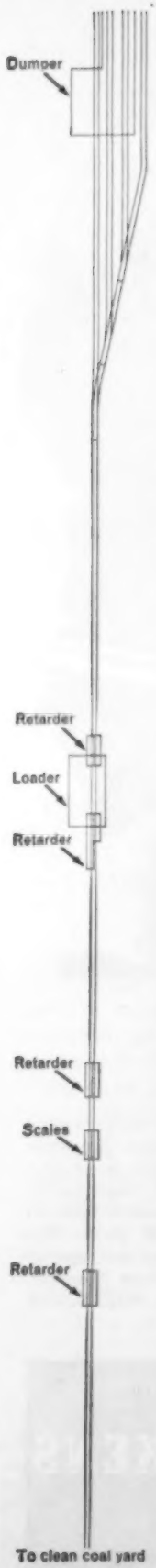
LUKENS

720 tons of coal per hour loaded safely with Union Switch & Signal Car Retarder System

At U. S. Steel's coal cleaning plant, Corbin, Kentucky, a system of four car retarders is used to direct coal cars through loading, weighing and coupling operations. This Union Switch & Signal Car Retarder System places cars with speed and accuracy, eliminates a safety hazard and results in a substantial operating saving.

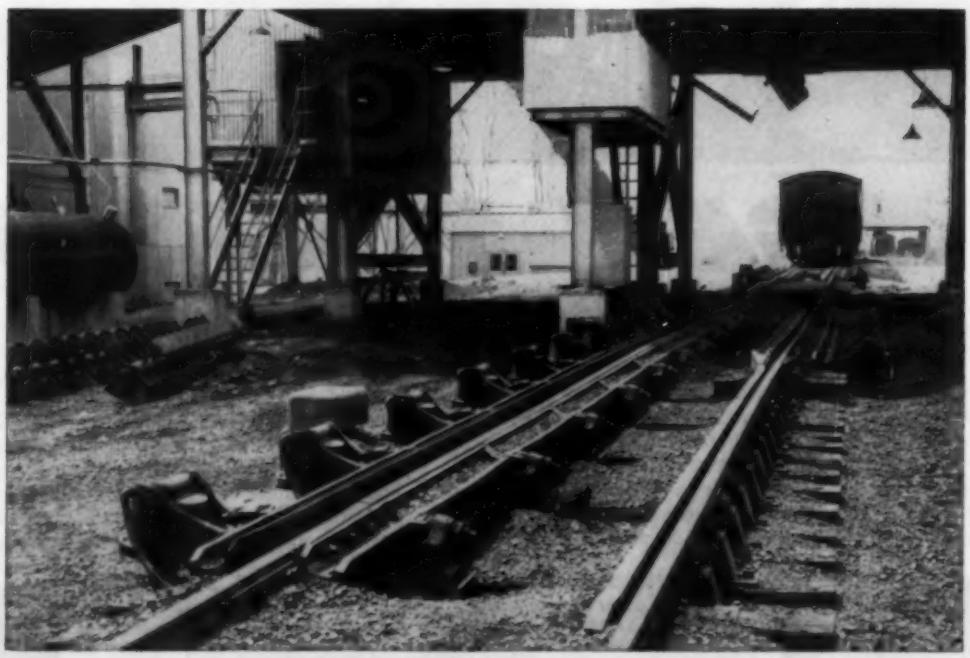
Empty cars are moved to the loading track where the pushbutton-controlled retarders take over while the cars are loaded. Cars next run by gravity to the retarders at the scale house, are weighed and then run by gravity to a collecting point at another retarder. The entire job is handled quickly and economically by two operators. In three years of operation, the system has been trouble-free and maintenance-free.

Let us help solve your car control problems. We will be happy to discuss with you—without obligation on your part—how a Union Switch & Signal Car Retarder System can speed up operations, promote efficiency, reduce safety hazards. Write today for more complete information.

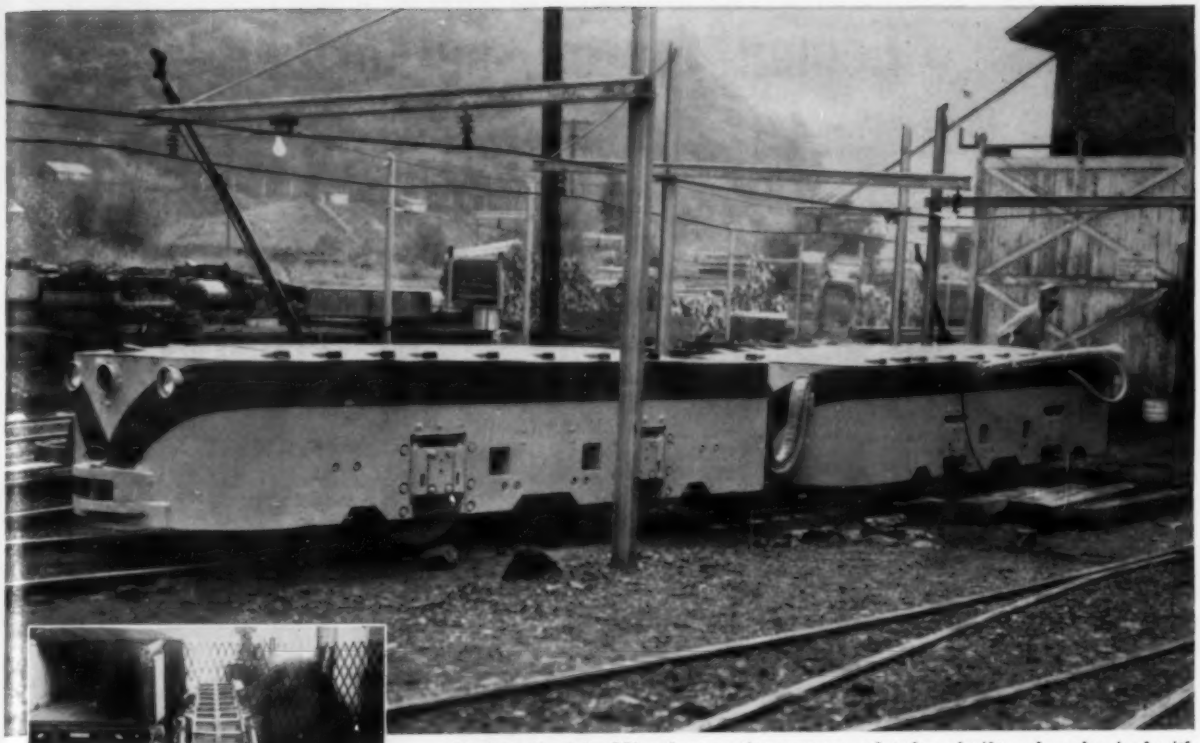


The first retarder receives and controls empty cars before the loading. Under the loader the cars are slowed down by the second retarder, then move gradually to receive an even load distribution. The third retarder slows the loaded cars for accurate weighing. Just before the coupling, the cars are brought to a complete stop by the fourth retarder.

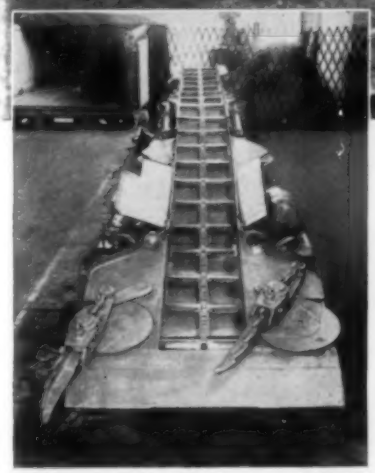
Empty cars moving to loader are controlled by first retarder, in background. This retarder arrangement provides for availability of 8 empty cars in advance of loading point. As loading progresses, second retarder, in foreground, controls movement of cars being loaded. This system of car handling moves cars with accuracy, assures a full, evenly distributed load.



UNION SWITCH & SIGNAL
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY
SWISSVALE, PENNSYLVANIA
NEW YORK ..... PITTSBURGH ..... CHICAGO ..... SAN FRANCISCO



Back on the job. *Mine locomotive was completely rebuilt and modernized with contactor control, air brakes, air sanding and new bumpers.*



Not brand new but National new. *Rebuilt coal loader is one of many types of machines serviced by National's two coal field plants; in Bluefield, West Virginia, and Harlan, Kentucky.*

Get complete equipment rebuilding from National

The Specialists in electric coils/repair service

National offers not only electrical repairs but complete rebuilding service on all types of mining machines.

Often you'll find that National-serviced equipment performs better than new. The reason—equipment is not just restored but is modified to incorporate new developments and upgrade original performance. Motor windings, for instance, have the very latest and best grade insulation tailored by National to your requirements. The latest improvements in control and mechanical systems bring your equipment up-to-date at the time of complete overhaul.

National completely dismantles, inspects, rebuilds and tests. The work is done by specialists. For fast service, contact our nearest plant or your National field engineer.

National Electric Coil

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DIVISION OF McGRAW-EDISON COMPANY

COLUMBUS 16, OHIO

ELECTRICAL ENGINEERS•MANUFACTURERS OF ELECTRICAL COILS, INSULATION, LIFTING MAGNETS•REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

Leman "factory-authorized" repairs will put your equipment back to making profits in a hurry....

PROMPT REPAIR SERVICE PICK-UP RIGHT AT THE JOB OF DAMAGED OR WORN EQUIPMENT

Yes, even the heaviest mining machines and equipment are back on the job faster when Leman Machine Company does the repair work. A complete, modern machine plant and full staff of specialists enable Leman to assure you of prompt, efficient service that saves time and money.

The plant and equipment layout at Leman's is similar to the manufacturer's production line. There's no wasted motion to boost repair costs and you get workmanship equal to that of the original equipment producer.

LEADING IN MINING EQUIPMENT REPAIRS FOR OVER 35 YEARS

Authorized, recommended agency for repairing Jeffrey Equipment. Equipped to repair, rebuild or remodel all mobile loading and mining equipment and electric locomotives.

Long list of successful repair jobs includes Jeffrey, Joy, Goodman, Lee-Norse, Clarkson, Long, General Electric and Westinghouse mining equipment.

- Restore even heaviest equipment to original condition.
- Make modifications converting old machinery to latest models.
- Equipped to design new parts for specific requirements.
- Pickup and delivery right to job-site reduces down time of equipment.

Phone or write for prompt, courteous service on your repair needs.

LEMAN MACHINE COMPANY

BOX 236 PORTAGE, PENNA. PHONE: PORTAGE 2051

Real weatherbusters are the 10 Mack LRSW's that keep Red Parrot Coal Company in full production year 'round. LRSW's feature 320 or 335 h.p. diesel engines for dependable power . . . eight-speed Mack transmission for super-duty service . . . power steering and sharp turning angles for unmatched agility . . . exclusive Mack Balanced Bogie—the four-wheel, rear-axle drive with inter-axle Power Divider differential that delivers the most power to the wheels having greatest traction—for hauling big loads through mud, sand, or loose gravel that would stop other makes.

"With the weather we've had," says Red Parrot Coal,

"Only MACKS could have kept us going"

"Over a year ago we acquired 10 LRSW Mack trucks," says Red Parrot Coal Company. "This fleet has operated through two difficult winters, either of which would have closed down our operation with our former equipment. Many of our roads are of temporary construction on the coal benches. When they are subjected to the freezings and thawings and soaking rains of winter, this presents a real problem. These narrow benches demand a lot of mobility from our trucks to permit turning and maneuvering in the restricted area available. The access roads are permanent but necessarily include steep grades, some as steep as 13%, and numerous sharp curves.

"We feel we have a fair proving ground for trucks and place a real demand on them with the 4,000 tons per day we move.

"The Mack LRSW is satisfactory in all respects and we are convinced it is more than rugged enough for a rugged job."

Why not find out—first hand—about the matchless earning power of big Macks on your big jobs. Ask your Mack branch or distributor for the names and addresses of nearby Mack users. Mack Trucks, Inc., Plainfield, New Jersey. In Canada: Mack Trucks of Canada, Ltd.

MACK
FIRST NAME FOR
• **TRUCKS**

NOW! REPUBLIC BRINGS YOU 3 MAJOR ADVANCEMENTS IN MINE ROOF BOLTING*

HERE'S THE ASSEMBLED UNIT WITH REPUBLIC RS-1 EXPANSION SHELL

Advanced, all-purpose RS-1 has strong, flexible leaves for simple installation, and quick, efficient tightening. Narrow base support for the leaves assures easy, dependable expansion.

Republic offers the largest combination of roof bolts, roof plates, and expansion shell assemblies available —for virtually any application, in any type of formation. Get details now.

MINE ROOF BOLT MATERIAL CONTROL CERTIFICATE
Republic Steel Corporation hereby certifies that the mine roof bolts included in mill order number _____ were made from the following steel:
The above figures are entered as contained in the official records of the Corporation.
REPUBLIC STEEL CORPORATION
General Offices • Cleveland 1, Ohio

MATERIAL CONTROL CERTIFICATE with every Republic Roof Bolt shipment gives specific physical properties of steel used. Data includes yield point in pounds per square inch, yield and break point in pounds, other information. Guesswork about performance is eliminated!

1 PRECISION-TAPERED PLUG

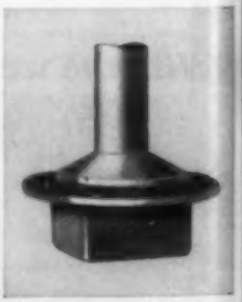
Engineered for proper shell expansion. Note angle of taper in illustration—the precise degree required for strength, dependability, and quick, efficient tightening. This improved Republic plug is versatile and adaptable, and is particularly effective in relatively soft formations.

2 HEAVY-DUTY SUPPORT NUT

Square nut provides over 40% better support than even the best previous method, yet maintains proper bolt tension by stripping at approximately 50 pounds torque with no damage to bolt threads . . . can be applied either side up to expedite assembly.

3 IMPROVED SELF-CENTERING HEAD

Compact, one-piece head eliminates need for second washer. Heavy flange, and thick, reinforced washer are guided cleanly and firmly into position in bolt plate. Entire unit forged, for ruggedness and strength. Standard 1⅛" head available with ¼" and ⅜" bolt sizes.



CALL YOUR REPUBLIC REPRESENTATIVE OR MAIL COUPON FOR MORE INFORMATION

All 3 advancements shown here as seen at the recent Coal Show

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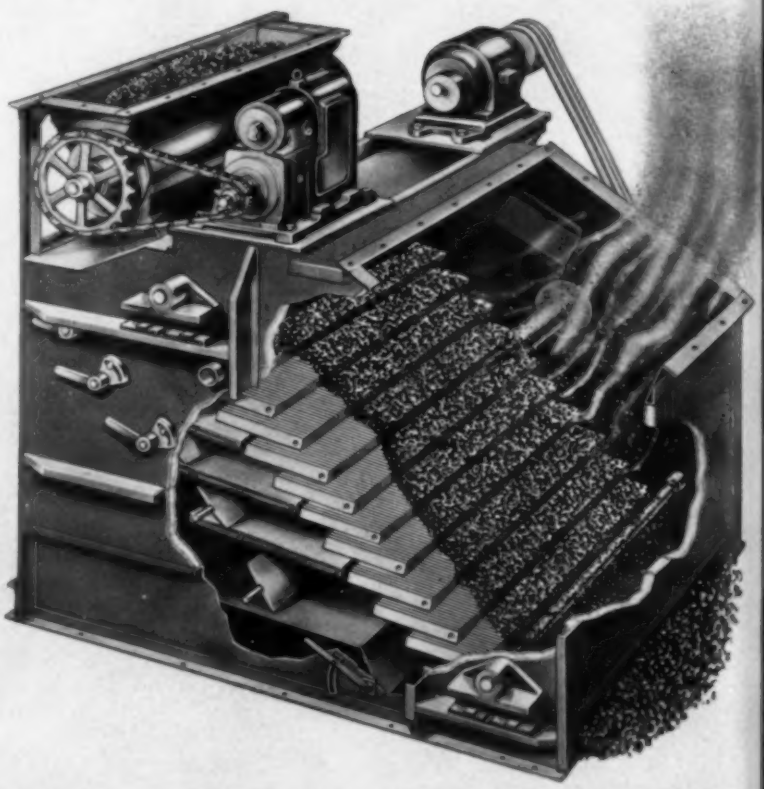

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COAL AGE

JULY 1959

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Effective Cost Control

Basic Approach

The "industrial engineering" concept, based on measuring actual costs against potential costs scientifically arrived at and thus more realistic, rather than against the costs of the past.

Goals

Generally the minimum in overall cost and specifically such collateral objectives as forecasting of costs, planning haulage, organizing shop work, streamlining paper work, and estimating the effects of nonroutine jobs on cost.

Key Steps

1. Management acceptance and understanding of the basic principles.
2. Active participation of supervisors.
3. Employment or training of industrial engineers or their equivalent.
4. Allocating to industrial engineering or cost control the rank and authority necessary to achieve the desired results.
5. Adoption of the time-study principle.
6. Methods revision based on time study and analysis of both cycle and equipment.
7. Establishment of standards of performance, with provision for necessary re-study and review.
8. Establishment of incentive-payment plans for foremen or foremen and workers (optional, but commonly accepted as one of the final steps in getting minimum cost).
9. Development of production and delay reports based on standard times or performances, with provision for rating each new section or operation.
10. Adoption of cost and production budgets.

Rewards

Cuts of 25% or more in direct mining cost and up to 50% or more, in a few instances, in face cost.

Organizing for Control

FIRST IN IMPORTANCE is understanding of cost control, how it is attained and what it can—and cannot—do. This understanding must be gained by both top and operating management.

Second is incorporation of the foremen into the program on the basis of active participation.

ADDING THE FUNCTION—The two major methods of incorporating industrial engineering cost control into the operating setup are:

1. Establishment of the company's own industrial-engineering, standards or cost control department. If the company is small, the job may fall to the lot of one man—perhaps the superintendent.
2. Contracting the job of setting standards and control systems to an outside specialist.

PROVIDING PERSONNEL—If the company undertakes to handle its own work, the first job is to provide the necessary specialized talent. Perhaps an experienced man or men may be hired. Or they may not be available or the company may prefer to train its own or have them trained. If, as in a small organization, the job falls to one man, he probably will have to be one already on the job and therefore require training.

Whether hired or trained on the job, the preference is for starting with men with mining experience. Their judgment is better when it comes to such things as arriving at a man's "normal" working pace, and they are in a better position to present the new concepts to other operating personnel, and to work with such personnel in getting them applied effectively.

Desirable Qualities—In selecting men for industrial-engineering work, experience has shown that certain personal characteristics are important. They include: ability to lead people and get them to cooperate; understanding of and ability to use mathematical and basic engineering techniques accurately; analytical interest and ability; and the patience and tenacity to see a project through to its conclusion.

Another key element is the understanding and cooperation of the foremen. There is unanimous agreement that they also must understand the aims and objectives in standards-setting, and must be familiar with and able to apply standards-setting principles. Thus, all foremen should be able to make time studies and apply the results.

ORGANIZATIONAL PLACEMENT—Two common approaches to fitting the industrial-engineering function into the organizational setup are:

1. Separate status for production and standards, with care, however, to keep standards on an equal plane. This means making industrial engineering a staff or fact-providing function though ranking it in importance with the production function.
2. Allocating to industrial engineering a degree of line or production responsibility in addition to staff status.

Which plan, or modifications thereof, to adopt depends, in the last analysis, on individual circumstances. The goal is to provide the industrial engineering or standards department with the status and authority necessary to insure that its operations pay off. Too much authority can be bad—and also too little.

Time Study

AIMS IN INDUSTRIAL ENGINEERING include (1) revision of methods to attain maximum efficiency and lowest cost, (2) checking of results to see that they have met with expectations, (3) establishment of incentives to stimulate

the best efforts of management and men.

The time study is the tool. It may be done regularly to see that performance is up to snuff, or it may be done only long enough to establish a new method and determine that it is getting the expected results. The latter tends to cut industrial-engineering manpower. Studying and checking face operations normally produces the maximum in results, but any or all other operations may be studied as well.

BASIC STEPS—Steps in collecting the necessary basic data, or "elemental" or "raw" times, are basically the following:

A. Break the operation being studied down into the smallest practical elements that can be timed. The goal is to have a breakdown that will permit each element to be timed repeatedly without hesitation, and by anyone with a list of the elements. The first step therefore is to study the operation long enough to be able to break it down into elements that can be precisely described and timed. The description of the elements includes the "Start" and "Stop" points, arranged so that the stop point of one element is the start point of the next.

As an example, the process of unloading a shortwall cutter off a crawler truck might be oversimplified into two elements:

1. Tram.
2. Unload.

Actually, the breakdown that would provide a really useful working basis might be as follows:

1. Tram.
2. Unload tools.
3. Get in position to pull off rope.
4. Pull off rope.
5. Cut jack hole.
6. Set jack.
7. Tighten rope.
8. Position safety jack.
9. Unload.

B. Describe the elements so that they are recognizable by anyone familiar with the operation. In addition to this description, work up single-word summaries or symbols that can be quickly written by the man who actually does the studying.

An example of an element description in auger mining is as follows:

Head back:

Start: When drilling stops. Include uncoupling chuck from flights and tramming drilling head back.

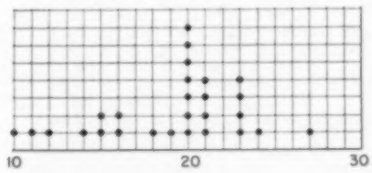
Stop: When head stops rearward motion.

C. Take the actual times, using a form on a clipboard and a stopwatch. A ruled sheet of paper may be employed or a form may be mimeographed or printed for the purpose. An accompanying example has columns for adjustment factors, discussed in the following section. The watch should be of the snapback variety graduated in hundredths of minutes.

Determining Standard Times

TIME STUDY of a particular operation should be continued long enough to be sure that representative times are obtained. Some recorded times will show considerable variation. But whether the variation is little or great the question becomes one of determining the basic time.

One method is to average the times. Another is to chart them by frequency, as in the accompanying illustration. In this example, the most-frequent time was



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TIME STUDY OBSERVATION SHEET

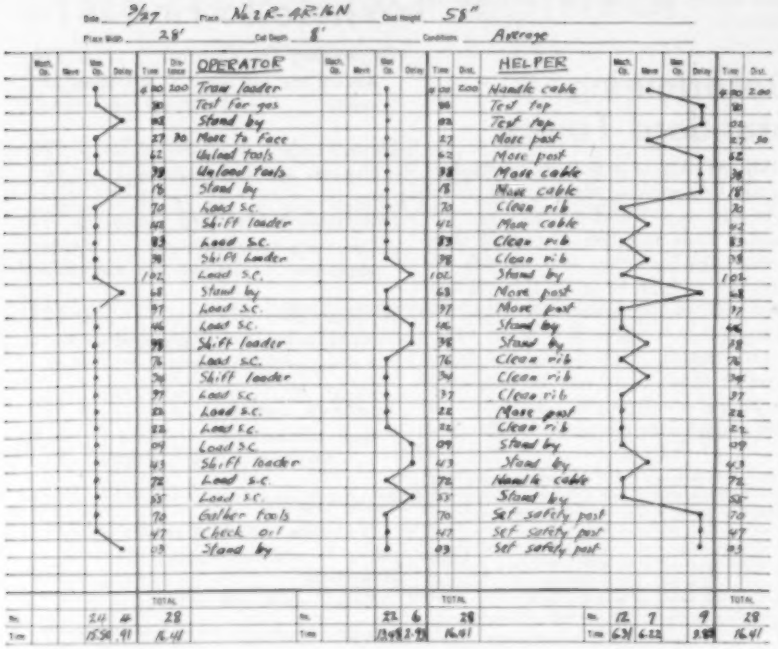
OPERATION: ROTARY ROOF BOLT DRILL OPR
GENERAL DATA: 8-60" BOLTS + (2) 2"X6"X14" HEDERS. 4 POSTS PER CUT — BOT. DRY LEVEL - DRILLING CONDITIONS 53" FIRM SHALE 2" S.S. + 1" S.S. + 2" S.S.

SHEET OF
STUDY NO. MINE 8
DATE SHIFT 1
SECTION #5
OPERATOR(S)
FOREMAN
OBSERVER
STOP: START: 10:00

	ELEMENT	ACT. MIN.	ACT. RATE	NORM. MIN.	REST FACT.	STD. MIN.
	MOVE 90'					
	TURN MCH		100			
	MOVE 50'					
W.3	WAIT ON S.C.					
	MOVE 50					
X1	IDLE					
	MOVE TO CONTROLS					
	POS. FOR HOLE					
	POS. HDR					
	PLACE STEEL					
	DRILL #1 HOLE					
	CHANGE STEEL					
	DRILL #1 HOLE					
	PLACE EXTENSION					
	DRILL #1 HOLE					
	REMOVE STEEL					
	PLACE BOLT					
	TIGHTEN BOLT					
	LOWER HEAD					
	RACK HEAD TO NEXT HOLE					
	POS. HEAD					
	TOTAL	5.70				

TIME STUDY OBSERVATION SHEET (shown here) contains space for noting all data necessary for a complete study of the elements of an operation.

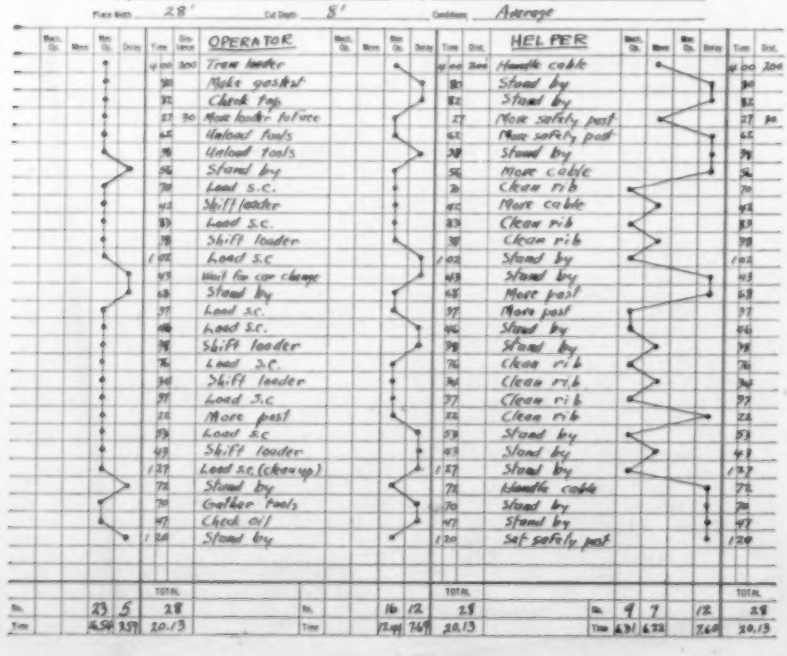
Method Study Chart



BEFORE . . .

METHODS STUDY using special chart to permit showing relationship of operator, helper and machine at all times during the cycle. The aim is to pinpoint machine and man waits as the first step in reducing or eliminating them.

Method Study Chart



AFTER . . .

HOW OBVIOUS REBALANCING of the work load between operator and helper reduces total time for loading out a cut. The cycle still contains significant waiting time, which might be further reduced by study of other unit operations.

20/100 sec. The arithmetical average would have been 19/100 sec. The frequency chart, some industrial engineers contend, automatically eliminates abnormal times but at the same time keeps them available for inspection.

TIME CONVERSION—Having obtained the "average" or "typical" elemental or "observed" times, the next step is to convert them to "normal" times, and then include the proper adjustments for fatigue and the man's personal needs. The conversion of the "observed" time to "normal" is one of the areas in which accurate judgment is required. Normal pace is the working speed of a qualified operator at daywork tempo. (Many define this as the equivalent of walking at 3 mph on smooth, level ground without load.)

If, as an example, the observed time for a particular operation is 2 min and the time-study man concludes that the man is working at 10% faster than the normal pace, the observed time is increased to 2.2 min to obtain the "normal" time. This step is an essential one regardless of the particular goal. Otherwise, any attempt to revise methods, as an example, would fail because the times used were unrealistic, being either too great or not enough.

If the goal was also establishment of an incentive system, accurate determination of "normal" times is even more vital, since an incorrect normal will result, in one direction, in excessive earnings or, in the other, in little or no extra money, with consequent discouragement and failure.

FATIGUE ALLOWANCES—No man can work all-out for a full shift without rest. Consequently, fatigue must be allowed for by an adjustment of the "normal" times to convert them to "standard" times for performance measurement. The allowance varies with the job. A loader operator, for example, might be given an allowance of 10%, while the helper, with shoveling and other heavier tasks, might be allowed 25%. Next, the man must be accorded time for personal needs, for which an allowance of 5% usually is made. Thus, if the normal element time was 2.2 min, it would be increased by 15% in one instance and 30% in the other to achieve a "standard" time—a time matched to the pace the man could keep up the entire shift.

Since many operations, such as loading out a cut of coal, include both manual, or "man-paced," and machine, or "machine-paced," elements, and men and machine are expected to finish together, it is necessary to increase any times recorded for the machine part of the cycle by the same allowances granted to the men. For example, a

loading machine could complete a cut in 18 min of actual machine time cut after cut. The helper, shoveling loose coal and doing other work, could finish the first cut in 18 min with the machine but he would have no rest or other time out and manifestly could not keep the pace the entire shift. Thus, a standard set on the rate the machine could attain would be impossible for the man to maintain over the shift, so if machine time was used it would have to be increased so that the man could keep up and, if an incentive system was in operation, reach incentive rate.

Methods Revision

WHEN AN INDUSTRIAL engineering program is adopted the aim in the initial time studies is to start on a revision of methods—and possible equipment—to attain minimum cost. Once the revision is completed, time study can then be employed to see if the desired results are being achieved and further, to assess, if desired, the possibilities of new types of production facilities in place of those originally studied.

Time study therefore is the foundation for methods study. Balance is the goal, which in turn means eliminating waits, particularly of men on machines or on each other.

STANDARD DATA — Actually, although time study is the key in revising methods and checking on results it can be largely dispensed with after the initial shakedown period. The thing that makes this possible is "Standard Data," or compilations of standard times for various operations under varying conditions in the form of "Standard Data Tables" or "Standard Data Manuals."

If a new opening was planned, for example, using previously proven units, the date on standard operating times and production rates determined in the previous opening could be used to set times and production standards at the new. The saving in time-study expense is considerable. Many advocate maximum use of "Standard Data" for that reason. Of course, if a new condition is encountered or a new machine is involved, time-study procedure would have to be followed, unless data could be obtained from another user of the same machine under similar conditions.

METHODS STUDY PROCEDURE— The goal in a methods study is enough information so that the particular operation can be studied step by step, both men and machines together. Ideally, a film strip would be the best means of making such a study, with times being obtained by counting the frames consumed in covering a specific element. Several types of charts have been developed as substitutes for film strips. One is shown in the accompanying illustrations. It provides for parallel charting of the work of both men and machines.

The first step is to study the operation, in this instance loading out a cut of coal. The aim is to break it down into the proper elements and show the relationships of men and machine at all times during the cycle. When these have been plotted on the chart and the times have been added, the engineer or analyst is in position to initiate a methods revision.

ELIMINATING WAITING TIME— In the example illustrated it will be noted that there was considerable standby or waiting time in the original cycle, particularly on the part of the loader helper. How a revision might work out is shown in the second of the two charts. As a result of rearrangement of duties along obvious lines, the saving per cut is 3.72 min, meaning that output per shift should increase 18½%.

It will also be noted that even after methods revision both operator and helper have some necessary standby time. The helper in particular is standing by a total of 2.3 min even after rebalancing. Can this standby time, and the standby time of the other men in a unit crew, be put to effective use? Frequently it can—by revising the cycle with or without changes in equipment.

Analysis of methods in this or similar fashion is a major step to attainment of the most efficient system, but it is not the only one. In fact, complete success is not likely to be achieved unless the charts are supplemented by check lists of questions designed to force the analyst to consider all possible ways of improvement, including, for example, number of moves, accessibility to tools, placement of controls, character and training of the man in relation to the job (Is he the right one?), and so on.

Incentive Systems

WITH TIME AND METHODS studies providing the most efficient production setup and an accurate measure of what performance should and could be, management then is in position to adopt an incentive-pay system or systems to further enhance the benefits. The incentive plan may be limited only to supervisors, which is the common practice in coal mining, or it may, as in some instances, take in both management and men.

Incentives for foremen differ from bonuses, such as Christmas and profit-sharing, in that they are paid on definite measured performance by each individual, and thus directly reflect effort and skill. They involve (*Coal Age*, January, 1958, p 104; October, 1958, p 86) the establishment of definite standards for performance, proper application of the standards, controls to make sure that safety and other factors are not shortcut, and employment of capable personnel to administer the plan.

Pitfalls to be avoided in setting up an incentive plan for foremen include:

Failure to sell the plan to all levels of management.

Use of the incentive plan as a "whip" for production, rather than as a tool for helping the foreman.

Partiality in the application of standards.

Use of adjustments unwarranted by conditions.

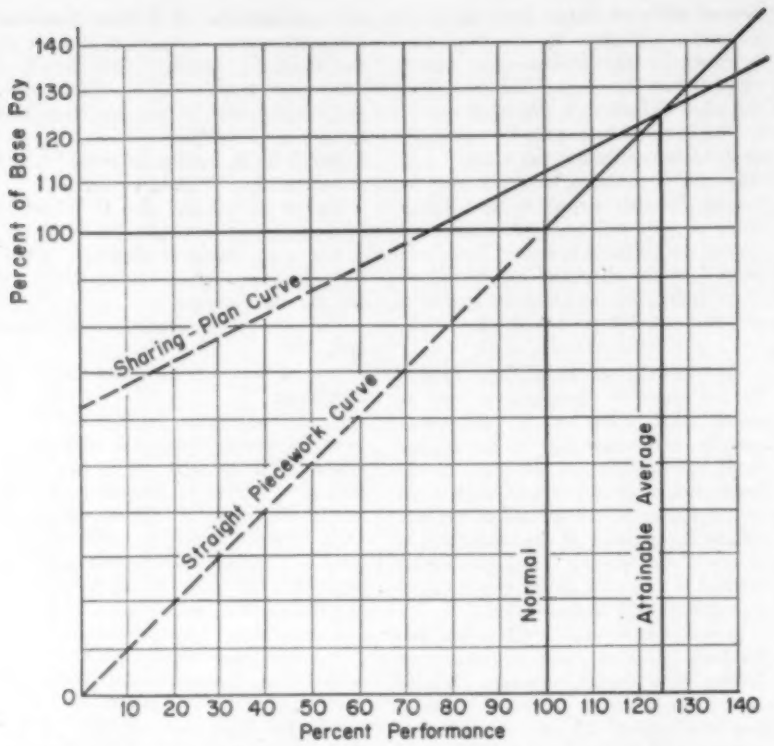
Failure to change the standard when methods, crews, equipment or practices change. For example, if an incentive plan is to be fair to foremen and company (and to men if they are included), each section should be regularly reviewed, perhaps each week, and the bogey for the foreman and crew set in accordance with the section rating—normal, good, fair or poor, for example.

A wage incentive plan also can be used to pay workers extra money for performance above normal—in other words, for doing assigned work in less than normal time. If a wage incentive plan is adopted, an essential decision is the performance-pay relationship, or curve.

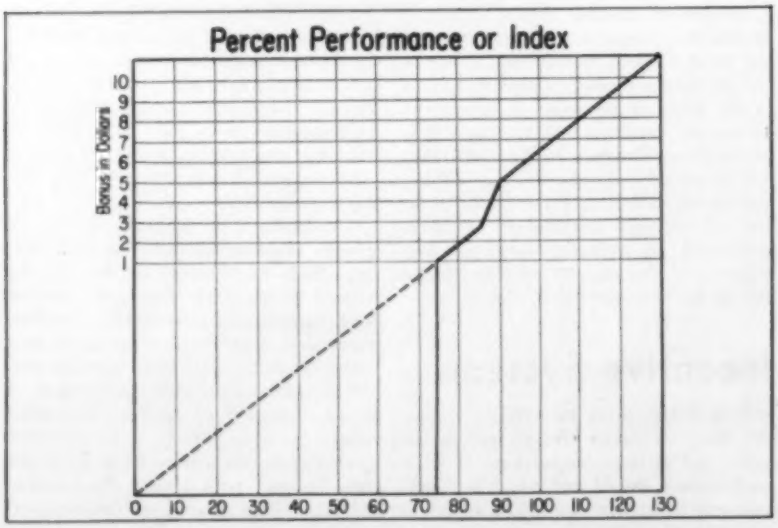
INCENTIVE-PAYMENT PLANS — A common method of payment is the hour-for-hour straight-piece-work curve, or 1% extra pay for each performance percentage point above normal, or daywork, performance. As a rule it is expected that the workers can attain an average performance of approximately 30% better than normal.

Conditions can fluctuate widely in certain occupations, including coal mining. Such fluctuations are beyond the control of the workers and, to some extent, management. Frequently, development and application of accurate time standards that reflect these variable conditions are economically impractical. A popular method of applying incentives under these conditions is to slant the performance-pay curve away from the "one-for-one" ratio toward the horizontal. The effect of such a "sharing-plan" curve in comparison with the straight piecework curve, is to pay some bonus for less than normal performance, a higher percentage of bonus for performances under the expected average incentive performance, and a lesser percentage of extra pay for performances above the expected average (see chart).

The advantage of the sharing plan is reduction of wild fluctuations in pay in comparison with, or in relation to, the unavoidable fluctuations in performance. Over a period of time the averages of



HOW INCENTIVE PAYMENT PLANS compare at various stages of performance. The sharing plan is suggested where it is difficult to establish precise standards because of unavoidable severe fluctuations in performance. Plan shown in chart below provides for the extra effort necessary at one point.



pay-performance relationships should be approximately the same with both curves.

Variations of either curve are possible, and are used. One in actual use for foremen (see chart) is based on paying at 74% of section potential, arrived at by dividing this potential, determined from previous time-study and standard-date compilation, by actual performance in tons and multiplying by 100. At one point where extra or outstanding effort is required earnings are at a higher rate, after which the curve reverts to a straight line.

The bonus to be paid at attainable, or expected average, performance is a policy decision. Generally, it is somewhere between 20 and 35%, but can be set between 10 and 50%. Naturally, if the pay-performance ratio is other than 1% for 1% (0% at normal, 25% at 25% above normal), there must be a formula to convert performance to incentive pay.

Payment of 1% extra pay for each 1% extra performance (the "one-for-one" plan) results in a fixed direct labor cost per unit of output for any performance above normal. However, such a plan offers two sources of cost reduction: attaining and maintaining performance above normal; and reduction of overhead costs in relation to direct labor costs.

Under the incentive system the man or men earn extra pay by doing a certain job in a certain time as, for example, completing a cut in 28 min instead of 33, or by achieving more than the standard, or base, production level in terms of tons per shift, per week or per month. In both instances, the emphasis is on a carefully determined standard, rather than on exceeding previous production figures, since even the higher figures might be well under what the use of industrial-engineering techniques would show should be achieved.

STANDARDS REVIEW—In coal mining major variations in conditions can occur, greatly influencing the results that are possible to achieve. Keeping pace with these changes and thus keeping the standard times used for rating performance and paying incentives realistic therefore requires that each new working section be rated and standard times set accordingly. If enough time studies are made under varying conditions, making actual time studies in new sections becomes unnecessary. Rather, the section is inspected and rated, and appropriate times or output derived from previous work ("standard data") are prescribed.

Of course, if a new machine is installed or if the system of operation is changed in any significant respect, sufficient new time studies should be made to develop realistic new standards.

The accompanying illustrations show two forms of rating reports which also provides an opportunity to remedy conditions that might otherwise cause undue delays, prevent the crews from reaching standard and, in consequence, up the cost.

Cost Control

AFTER STANDARDS AND METHODS have been determined, the next step is proper provisions for control. Production and delay reports are basic, and should be supplemented by budgeting and other steps for the lowest cost.

PRODUCTION AND DELAY REPORTS—An example of how production and delay reports might be set up is shown in the accompanying illustration. In this instance columns on changing distance and standard shuttle-car wait are included for more precise control

REVIEW AND RATING PROCEDURES for the establishment of specific performance standards take the guesswork out of control and insure fairness of incentives, if paid. They also can be employed to reveal bottlenecks and handicaps on performance.

over this important phase of the face operation.

On this particular shift, if incentives were being paid on the basis of standard times, the crew would have performed 280 standard minutes of work in 245 clock min, the latter representing 480 min minus 38 min for travel and other delay time, including the shuttle-car wait. Thus, they would have earned, on the straightline basis, at a rate of 114% (280 ÷ 245). In short, the men were trying and the fact that only 13 cuts were completed, rather than 20 or more was more the fault of supervision and of management policies. These included failure to anticipate the occurrence of certain troubles, such as getting the loader stuck, and, as another example, the tolerance of cable conditions almost certain to result in delays. Had the crew in contrast, loaded out only 11 places, it would have taken more clock time than standard time to complete the cuts, and thus the men would not have qualified for bonus pay.

This particular production and delay report shows the cost of delays in terms of dollars of expense, including fixed charges. The total assumed for this example is $1 per minute. The figure used at any particular operation would depend on the setup at that operation. In any event, showing the cost in dollars helps concentrate attention on the items that result in the greatest losses and at the same time are susceptible to correction, eliminating, of course, delays which are unavoidable, such as, travel, inspection, lubrication, etc.—though only to the extent of the standard allowed. This standard, in the case of lubrication, might be 6 min instead of the 8 shown.

The standard times, money, cost of delays and other similar data, with forms of this type, are filled in in the office, leaving to the foreman the task of recording maximum and minimum shuttle-car haul, cuts loaded out, shuttle-car change distance, and delays and delay times.

Budgeting

THE BUDGET represents the ultimate step in achievement of effective cost control. It provides an opportunity for showing, in tons of output and dollars and cents, what should be obtained after proper standards are set up, and at the same time provides an opportunity for comparing actual results with the

WEEKLY SECTION REPORT

MINE NO. _____ SECTION _____ SHIFT _____

Standard Crew _____ Men Week Ending _____

GENERAL CONDITIONS:

Describe any non-standard conditions: _____

Heading:	Width	Rock	Bone	Coal	Total Height

FACE CYCLES: Cutting and Drilling:

Standard Face Width			
Type Machine			
Length Bar			
Bottom Class		Cutting Time	
Cutting Class			
Coal Drill Class		Drilling Time	
Coal Face Class		Cutting & Drilling Cycle	

Shooting:

Face width			
Bug Duster Class			
No. Coal Holes			
No. Rock Holes		Shooting Cycle	

Loading:

Volume Matl./cut			
Bottom Class			
Top Class			
Loader			
Loading Class		Loading Cycle	

Haulage:

Avg. Haulage Dist.			
Top Class			
Bottom Class			
Cars (type)		Haulage Cycle	

Top Support:

Top Class			
Bolt Length			
Average Height			
Type Top (Drilling)		Top Support Cycle	

FOREMAN ENGINEER

REPORT OF
SECTION EXAMINATION AND CLASSIFICATION

MINE NO..... DATE..... I.E.REPR.....

SECTION LOCATION | SECTION FOREMAN | NO. OF MEN

PLACE	CLASSIFICATIONS		

AVERAGE CLASSIFICATION:

STD.TONS/SHIFT | STD.TONS/MAN | NO. CARS/SHIFT

COMMENTS

TRACK OR ROADWAY	SHOOTING
CUTTING	LOADING
DRILLING	CAR OR BUGGY CH'GE
DUSTING	TRIP CH'GE
POWER GOOD ☐ BAD ☐ INT. ☐	SUPPLIES

COMMENTS AND SUGGESTIONS

DAILY LOADER REPORT

Date 4/28 Shift 2 Section 4R 16N

Loader No. 3R Shuttle Cars Used 2

Shuttle-Car Haul: Maximum 510 Minimum 285

Tons per Room Cut 25 X Cut 22 Hdg. Cut 18

Place No.	Std. Cut Time	Shuttle-Car Change	Std. Car Wait	Delays	Min.	Cost $
R2	24.0	60	1.3	Loader stuck - soft		
R3	24.0	60	1.3	bottom	38	38
X3	19.0	60	1.3	Splice loader cable	12	12
R4	24.0	80	1.9	Splice loader cable	13	13
R5	24.0	80	1.9	Heavy cut	18	18
R6	24.0	60	1.3	Car off - ramp	22	22
X6	19.0	60	1.3	Power off	9	9
R7	24.0	60	1.3	Clean fall R4	14	14
X7	19.0	60	1.3	Splice conv. chain	16	16
H1	18.0	70	1.6			
XH1	19.0	70	1.6			
H2	18.0	70	1.6			
R1	24.0	110	2.5	Std. Delay Allowances:		
				Travel	38	38
				Inspection	12	12
				Lubrication	8	8
				Shuttle-Car Wait	20	20
				Normal Unavoidable	15	15
				Total	235	235
				Std. Delay Allowances	93	93
TOTAL	380.0		20.2	Loss	142	142

	No. Room Cuts	X Cuts	Hdg. Cuts	Total
Tons per Cut	25	22	18	
Total Tons	175	88	36	299

PRODUCTION AND DELAY REPORT shown here is based on the use of standard times and shows the money cost of delays. Comparison of performance with engineered standards insures accuracy in cost control.

budget goal. This makes it possible to pick up losses immediately—as frequently as every day, in fact.

Budget systems and forms naturally will vary but the principles and functions are basically identical. Assume that a mine is operating four sections two shifts a day. Two of the sections are rated at 350 tons per shift, one at 380 and one at 300. The standard crew for three is 14, and for the fourth, 12 men. This rating is based on a reasonable minimum of delays and of course on the expectation that the units will perform at the pace determined as a result of time study and methods revision.

Management has orders or the expectation of orders sufficient for a four-day schedule for the week in question. With this as the goal, the budget is worked up to provide for the normal labor, materials, power and other costs, and for certain special work to the extent that costs for the week are not seriously distorted. The budget then is set up along these lines. In this instance, it is assumed that no incentives are being paid. If they were being paid to foremen, or foremen and men, the wage totals would reflect the extra payments expected from attainment of incentive pace.

Output, tons	11,040	
		Per Ton
Section labor, 512 shifts	$11,776	$1.067
Section supplies	1,435	0.130
Roof support, 72 shifts ..	1,584	0.143
Timber, bolts, other	2,043	0.185
Main haulage, dumping, 40 shifts	$880	$0.080
Haulage supplies	103	0.009
Track, 10 shifts	220	0.020
Track materials	350	0.032
Pumping and drainage, 8 shifts	175	0.016
Drainage supplies	60	0.005
Ventilation, 10 shifts ...	220	0.020
Ventilation supplies	277	0.025
Supply handling, delivery, 20 shifts	440	0.040
Preparation, 64 shifts ...	1,344	0.122
Preparation supplies	760	0.069
Maintenance shop, 60 shifts	1,380	0.125
Parts and supplies	2,260	0.205
General inside, outside, 10 shifts	215	0.019
Supplies	42	0.004
Idle-day labor, 8 shifts ..	164	0.015
Supplies	48	0.005
Power	1,480	0.134
Power supply, 10 shifts .	230	0.021
Power supplies	130	0.012
Office staff	380	0.034
Office supplies	32	0.003
Telephone, telegraph	103	0.009
Mine supervision	1,930	0.175
Outside supervision	700	0.063
Safety & inspection	320	0.029
Safety supplies	65	0.006
General & administrative	400	0.036
Special Jobs		
Complete mainline extension:		
Labor, 22 shifts	484	0.044
Materials	2,840	0.257
Start overcast, 4R 16S:		
Labor, 6 shifts	190	0.017
Materials	45	0.004
Start clearing site for new portal:		
Labor, 15 shifts	330	0.030
Materials	160	0.014
	$35,595	$3.224

The preceding is not, of course, in the sheet form an actual budget would take, nor is it presented as a typical breakdown of items. Rather it is intended only to illustrate the basic approach.

For the maximum degree of control, the weekly (or monthly) budget should be broken down into daily budgets, by section and department or activity, such as haulage or maintenance. These budgets, plus matching weekly or monthly budgets, are then given to the supervisors directly responsible as guides and standards for them. With these budgets, and with supplementary production and loss reports, such as those discussed earlier in this section, the stage is set for precise control, since the superintendent or other manager can see each day where the standards are being exceeded and, through the loss reports, the reason why. Thus remedial action can be immediate.

Budgeting can be quite precise, in spite of the variables inherent in mining. A number of companies report that they can come within 3 to 5% of actual cost in budgeting, which means that the budget is a reliable tool—the final weapon in the arsenal.

The Deep Mining Guidebook . . .

Low-Cost Development For Sustained Efficiency

Starting Points

1. Minimum investment in openings and plant facilities.
2. A basic layout providing for changes and expansion to take advantage of new developments in equipment and methods.
3. A mining system tailored to meet conditions and get the most out of the equipment selected.
4. An entry-driving and development system taking full advantage of modern methods, and providing for mining with a minimum of trouble and a maximum of efficiency.

Follow-Through

1. Locate portals for lowest mining cost throughout mine life, not forgetting the possibilities of water transportation, the desirability of moves or the need for auxiliary portals at certain development stages.
2. Mechanize shaft and slope sinking and rock tunneling, including outlining by drilling; also use gels, concrete additives and other auxiliary measures for solidifying strata, sealing off water inflow, etc.
3. Project for full retreat, if possible; if not, for as much retreat as possible; provide bleeders and escapeways, and give careful thought to pillar sizes and methods of removal.
4. Provide, in entry-driving, enough area for air and enough openings for other services; also adjust number of openings to give equipment employed the best possible opportunity. And, of course, mechanize entry advancement and any rock removal and disposal.

Locating the Portal

COST FACTORS—Locate mine and plan initial and future openings for lowest overall mine life. Reasons:

1. Increasing cost of opening and equipping, ranging up to $8 to $10 per ton of annual capacity, including preparation plant and other service facilities, as well as coal and surface rights, and averaging $3 to $6.

2. The increasing penalties incurred for extra haulage, air travel and man travel. Now, unproductive time is paid for at better than $3 per hour. For an extra half hour of travel, with 100 men employed underground, the cost is over $150 per day, for which no coal is received.

DATA REQUIREMENTS—These include:

1. **Depth of cover.**
2. **Dip of coal.**
3. **Major faults or wants.** Drilling, surface and outcrop surveys and level determinations are major methods of obtaining these types of information. Depth of overburden determines the economical number of holes. In average hilly country one hole up to 500 to 600 ft deep every 5 or so acres is fairly common practice, with more holes as depth decreases. Where there is no outcrop access and the coal is over 1,000 ft down, only an occasional hole is possible, but even this occasional hole can provide some assurance that there are no major wants or faults, and in addition provide elevations and cores.
4. **Topography.** Contours should be shown in 5- to 10-ft intervals, if possible, and the map should include enough of the surrounding area to permit good planning of railroad and road spurs, power lines, etc. It also should provide ready information on available land for auxiliary portals, coal storage, refuse dumps, fresh and dirty-water storage ponds, and so on. If the property is of some size, the production of such a map or maps usually can be accomplished by aerial surveying at a saving of one-half to one-third normal ground-survey costs.
5. **Water sources.** If surface runoff is insufficient, will wells be needed or dams for storage?
6. **Reasonably accurate costs** for such items as railroad and road-building, high-line construction, filling, foundation construction, etc., for varying conditions to permit the proper choice between alternative layout plans.

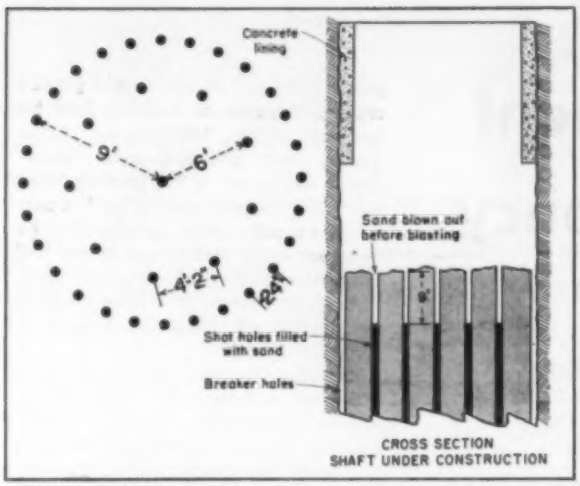
WATERSIDE LOCATION—If major markets can be reached by water, substantial savings in freight are possible, with resultant improvement in competitive position.

But if the location is back from the waterway how long a rail or truck haul is feasible? On the basis of examples to date, rail hauls of 10 mi for outputs of 1 to 2 million a year or more are apparently quite bearable. At 2 million or more, the thinking is for a maximum of about 25 mi where construction would not be too difficult. For trucks, a rough rule is half the rail distance, though a highway haul may have other limitations growing out of local or state regulations.

PLACING MAIN OPENING—Other things being equal, the main opening should be placed in the center of the property for lowest cost over its life. But if grades are pronounced (over 1½ to 2%, say), again with other things equal, the opening should be placed to favor loaded haulage and gravity water flow.

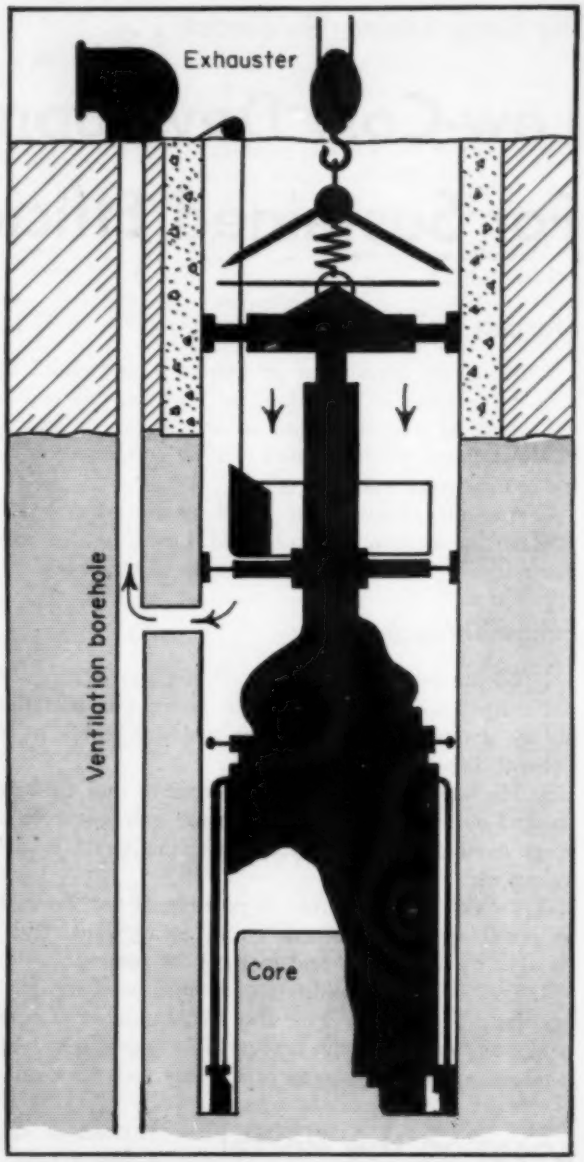
MOVING MAIN OPENING—Normally, the main preparation plant would be expected to last at least 20 yr, and usually the main opening would be expected to remain at that same location. But there are circumstances where, even though the preparation plant stayed put, the main opening should be moved. If tonnage was high, for example, the haulage distance increased rapidly, assuming mining on the advance, and conditions favored an economical overland haul, the main opening might be moved at the end of, say, 10 yr.

MULTIPLE OPENINGS—The conditions that might favor multiple openings include a hilltop where an outside haul road could be constructed fairly easily, or where the outcrop had been



OUTLINING BY DRILLING cuts cost of sinking shallow shafts by up to 50% when coupled with new grouting, mucking and lining techniques.

EXTENSIBLE BELT teams up with rock loader in the newest system for fast, economical slope sinking.



BIG CORING-TYPE DRILL sinks auxiliary air, man and materials shafts quickly and economically.

stripped. In addition to the obvious advantages of a lower cost haul—usually the situation with transportation on the surface—mining, ventilation and other operations, including travel arrangements, would be materially simplified.

A design for a large tonnage might be based on two or more openings, though only one preparation plant, because of the complications of trying to, say, hoist a high output out of one shaft or slope.

SEPARATING PORTAL AND PLANT—Putting the portal and the preparation plant at different places may be the better answer to the dual problems of locating the opening at the

Where to Find It...

Portal Location ..... p 203
Cost factors . . . Data requirements . . . Placing Openings . . . Space requirements.

Sinking Rock Slopes ..... p 205
Equipment . . . Supply-track position . . . Hand mucking . . . Machine mucking . . . Continuous sinking

Sinking Coal Slopes ..... p 206
Equipment . . . Special loaders

Raising Slopes and Airways p 207
Machine loading . . . Use of continuous miners

Shaft Sinking ..... p 207
Machine mucking . . . Outlining by drilling . . . Water Sealing . . . Simplified lining . . . Drilling shafts

Rock Tunneling ..... p 210
Initial excavation . . . Equipment . . . Tunneling performance

Mine Projection ..... p 210
Advance vs. retreat . . . Quick coal . . . Contour development . . . Closed and open panels . . . Providing bleeders . . . Pillaring practice

Entry Driving ..... p 211
Number of openings . . . Entry-driving setups . . . Rock handling

Field Reports

Mechanical Shaft Mucking—Overshot loader used in 37x14-ft air shaft. With 11-man crew sinking rate is 6 ft per shift. *Coal Age*, July, 1956, p 72.

Slope Sinking With Rock Loader and Extensible Belt — How this combination of equipment is used to attain rates of 4 to 10 ft per shift in 9x18-ft opening with four-man crew. *Coal Age*, November, 1956, p 68.

Drilling to Outline Shafts, Water Sealing, Simplified Lining—New drilling techniques increase depth at which outline drilling is possible. Drilling also used to facilitate grouting of both unconsolidated surface material and rock layers at low pressure with the aid of chemical additives. Special demountable form and use of boreholes speeds lining. *Coal Age*, June, 1958, p. 106.

Drift-Mine Development—Rope belts and shuttle cars serve loaders in developing two new mines in thin coal. Workings are columnized and synchronized. Separate headhouses include storage bins for coal and rock and belt facilities for rock disposal. Special provisions for handling supplies are included in portals. *Coal Age*, June, 1958, p. 78.

Safety in Mine Design and Development—How roof control, mining plans, power source and main haulage were set up for maximum safety. Entry driving and other development, using ripper-type miners, adjusted to provide alternate shuttle-car roads to belts. Slopes were driven mechanically and shafts were outlined by drilling, *Coal Age*, September, 1958, p 92.

High-Tonnage Punch Mining—Basic considerations and actual plans for developing small "punch" mines approximately 5,000 ft along the outcrop and 7,000 ft deep. Mining is by loader, shuttle car and belt to main line. *Coal Age*, January, 1959, p. 104.

best point for low mining costs, and the plant at a place where ample space is available for good design, ample coal storage, good water supply, access to a waterway, and so on.

Location of the preparation plant completely away from the mine for the same reasons is a further possibility.

SPACE REQUIREMENTS—Space for both present and future facilities should be provided for in the original planning for the portal or portals. The needs include:

1. Parking for as many cars as may be necessary, preferably on level or nearly level ground for easy movement at times of snow.

2. Coal storage. If not provided when the plant is built it may be necessary at a later date. Storage facilities for as much as a week's run or more of raw or prepared coal, or both, are not uncommon nowadays. Even where capacities are more modest, the trend is toward providing bin or ground storage for up to a half day's supply.

AUXILIARY PORTALS—Aside from providing a means of getting out the coal, openings into the mine provide travelways for air, men and supplies. The farther the openings are from the face the more expensive all of these—travel time in particular—become. It could pay, if deep shafts were not required, to make new openings for air about every mile; for travel and supply handling, every 2 mo or so.

Drilling shafts for air and supply handling—and even for handling small groups of men—is a handy and economical method where outcrop access is not possible. Cost is relatively low, and if the diameter is 4 to 5 ft or more they can be equipped with cages fairly easily and inexpensively.

Sinking Rock Slopes

EQUIPMENT AND FACILITIES—**Shovel, dragline or bulldozer** for preliminary excavation if the material is fairly deep and soft. A bulldozer normally is required in any event for miscellaneous earth moving and excavation, and for spreading refuse. These and certain other units frequently can be rented, rather than purchased.

Storage bin on surface unless muck is dumped directly to trucks. Normally, a bin will pay off by preventing delays and interruptions.

Refuse-disposal and service trucks.

Electrical substation or engine-generator plant.

Field shop.

Field supply house.

Field office, locker and change facilities. These, as well as the field shop and supply house, may all be in the same structure or separate buildings may be employed, including semiportable or prefabricated. Though it is not usual practice, the permanent buildings to serve the mine throughout its life may be erected in advance of portal development.

Fan or tubing blower, with duct or tubing.

Water supply for wet drilling, sprinkling and general use.

Pumping equipment, if necessary, for dewatering slope.

Concrete-mixing facilities, unless ready-mix is available at a desirable price. As an alternate to at least part of the concrete work, steel liner plate may be employed. Concreting or lining normally is done only for the softer section of material at the top of the slope. Below that, the natural-rock ribs normally will stand and the top can be taken care of by bolting or conventional timbering. Bolting also may be employed to keep ribs from sloughing or caving. Spraying with a sand-cement mixture on wire mesh also may be done to prevent spalling and disintegration as a result of temperature and moisture changes, or ribs may be coated with roof-sealing compounds.

Gel or other facilities for scaling off water, it encountered, unless other means are employed.

SUPPLY-TRACK POSITION—The usual belt slope also is employed for handling men and supplies. Consequently, the belt normally is placed to one side with the track at the other and the stairs in the center. However, all other arrangements have been employed, including increasing the height of the slope and putting the belt on crossbeams over the top of the supply track and stairs. In one instance, this double-decking was done to cut slope width in poor ground.

The belt or supply track may be separated from the other facilities in the slope by guard rails, low concrete curbs or walls, or a center line of roof supports. For easy walking, one mine built experimental steps and had men try them. As a result, the stairs were built with a 6-in rise and a 24-in tread.

Because of the length of time required

in sinking the longer slopes, and also because of the long tubing runs that would be required, it may become desirable to erect a center partition, thus establishing two compartments for ventilation. Rather than use shiplap or standard brattice lumber, thin-section plywood in standard-sized sheets offers economies in both purchase cost and cost of installation.

Methods of handling heavy inflows of water from soft water-bearing measures including standard grouting and also use of gel-type chemicals which solidify after pressure injection and render the material impervious.

Sinking Systems

Depending upo nthe mucking system adopted, equipment normally employed in slope sinking is as follows:

HAND MUCKING

Hoist on surface (50 to 75 hp, single drum, in most instances; same hoist may be continued in service to handle supply cars in regular operation).

Muck car.

Air compressor.

Drilling equipment. Hand-held or other unmounted drills may be used, but their footage is lower. At the other extreme, a track-mounted jumbo—one or two drill mounts—may be employed for maximum drilling speed in slopes up to 45 to 50 deg even though it may be necessary to pull it out between rounds or provide special parking facilities near the face. Between are column- or bar-mounted drifters or sinkers, as well as newer air-leg or jack-leg units.

Roof-bolting equipment rounds out the list, unless conventional supports are employed.

CREWS AND PERFORMANCE—Minimum crew for such a sinking job probably would be approximately as follows, these men also taking care of installation of lining and roof support: drilling shift—two or three drillers, mechanic or electrician, and a handyman (hoisting, supplies, etc.); mucking shift—two or three muckers, hoistman, truck driver and dozer operator.

It sometimes is possible for one man to take care of all hoisting and refuse disposal, although normally more than one are necessary, in which event the truck driver, dozer operator and any others employed normally will handle miscellaneous duties. And, as noted, all men will be available for installing lining, supports and the like. On this basis, average advance in a 7x15-ft slope would be 3 to 4 ft per shift—perhaps more with favorable conditions or jumbo or other high-speed drilling.

MACHINE MUCKING

Where muck is loaded mechanically, the equipment setup may be as follows:

Hoist.

Muck car or conveyor stystem. The latter may be chain equipment only, or a chain unit may be used between a belt unit, which eventually will become the slope conveyor, and the face. The latest additon to the group is the extensible belt. Its use is outlined later in this section.

Standard coal-loading machine, or rock loader of the standard, overshot or slusher type.

Air compressor.

Drilling equipment—substantially the same as with hand mucking. However, where crawler loaders are used and consequently cannot be hoisted out readily it may be difficult to use jumbos because of interference.

Roof-bolting equipment (unless conventional support is employed).

PITCH FACILITIES—Standard or conventional loading machines usually are limited to 20 deg or less, though the overshot unit of the track-mounted type can operate on somewhat heavier inclines. With certain types of slushers, mucking can be done at up to 50 deg, other conditions being favorable.

The "helldiver," though employed mostly in coal (see "Sinking Coal Slopes"), also may be adapted to sinking in rock at pitches up to 50 to 60 deg. Where conveyors are employed to move muck the practical limits are about as follows: belt 17 to 20 deg; standard chain 30 to 35 deg; special high-flight chain conveyor designed for hoisting work, 45 to 50 deg. Where the slope is long, chains must be used in tandem, since the practical working length usually is not over 300 ft, particularly if operated up hill.

With slightly different duties, crews for machine mucking can be about the same in number as with hand mucking. Rate of sinking in a 7x15-ft slope, including lining and support, usually ranges from 5 to 10 ft per shift.

MUCKING WITH EXTENSIBLE BELT—Latest addition to the list of slope-sinking tools is the extensible belt. In combination with a rock loader at one property (*Coal Age*, November, 1956, p 68), its use has resulted in sinking rates of 4 to 10 ft per shift in a 9x18-ft opening (before lining) on an inclination of 15 deg. The 36-in extensible unit was equipped with a special 100-ft takeup to permit tramming a safe distance back from the face before shooting. It discharged to a truck-loading bin on the surface.

The sequence of operations included drilling with telescopic leg stopers, concentrating first on bolt holes for roof support and then changing to the face. Next the holes were loaded and shot. Bolting, face drilling, loading, moving equipment back, etc., including shooting, took a four-man crew about 2½ hr. Loading was the next operation, with one man operating the loader, a second running the self-propelled tail piece of the extensible conveyor, a third acting as handyman at the face and the fourth working on the surface trucking away the rock.

Finished dimensions of the slope were 7x16 ft, achieved with a 1-ft concrete lining in part and a sand-cement coating on wire mesh on the remainder. The initial opening on the surface was made with a shovel and bulldozer, followed by installation of the concrete lining down to the solid.

CONTINUOUS SINKING

In addition to growing effectiveness in coal, continuous miners also are proving quite effective in slope sinking and other rock work where conditions are not too difficult. Equipment usually employed is as follows:

Sinking machine. To date, these have been of the boring type and have been used only in sinking belt slopes on inclinations of around 20 deg or less.

Conveyor system (muck car an alternate).

Roof-bolting equipment (unless conventional support is employed).

The use of continuous-type mining-and-loading machines for slope sinking is a relatively new development. Results so far indicate that advances of 10 to 30 ft per shift are possible, depending upon the hardness of the rock. Since hard sandstone, limestone and the like still are tough for mining-and-loading machines, they normally should be considered only where shales and other soft material predominate.

Sinking Coal Slopes

EXCEPT THAT THE PRODUCT normally is not dumped to refuse, sinking slopes in coal is substantially similar in practice to sinking in rock. Equipment normally is of the coal type, and aside from loaders and the like, may include coal cutters, unless pitch, interference or other conditions prevent. With some exceptions electric coal augers are standard for drilling, and the cycle corresponds with the cycle in a room face.

Cars or skips may be loaded by hand up to 75 to 80 deg. Conveyors may be loaded by hand up the limit of 45 to 50 deg for the special high-flight hoisting type. With loading machines, the

usual limit for conveyors is around 20 deg. The maximum nose-down pitch for continuous miners still is to be determined, but they are promising candidates up to 15 to 20 deg.

SPECIAL MUCKERS — The "helldiver" is one of the special machines for fast loading in slopes up to 50 deg. It consists of a scoop on the front end of a weighted truck (*Coal Age*, May, 1951, p 100). With the scoop down, the helldiver is dropped into the loose coal at the face. In hoisting, the scoop is raised automatically and the entire unit is pulled to the dumping point—normally a hopper under the track with an opening between the rails. The hopper is above the haulage level and false rails permit hoisting over the level track. Coal is transferred from the hopper to cars on the level road by an elevating conveyor.

In 4½-ft coal, places 10 ft wide, with crews of 3 to 4 men, average production with the helldiver is one 7-ft-deep cut per shift, including installation of permanent roof supports and other necessary operations. With loading machines in slopes under 17 or 18 deg, 5-ft coal or thicker, the usual advance is 1 to 3 cuts per shift, with the higher figures possible as a rule only where there is little need for installing permanent supports. Advance with hand loading, whether into cars or conveyors, seldom is over one cut per shift with a 3- or 4-man crew.

Raising Slopes and Airways

MACHINE LOADING is as desirable in raising slopes and airways in either coal or rock up to say, 20 deg, as in siking or production on the level. Although equipment can be installed to take cars to the face, the preferable transportation medium is the conveyor up the point where the material will run on sheet iron, which is around 30 deg. At around 35 to 40 deg, coal will begin to run on the bottom rock, and above approximately 45 deg, checks or batteries are required.

RAISING WITH CONTINUOUS MINERS — Where raising is done in coal, continuous miners have been successfully used in pitches up to 15 deg or better. In one instance, using pickup loaders, shuttle cars and cross-measure shakers for gathering, six airways were driven 1,500 ft up pitch to the outcrop by ripper-type continuous units with a substantial saving in cost over other methods. Maximum pitch encountered was 12½ deg.

In addition to raising parallel airways with conventional equipment operated from crosscuts off the main slope big drills also have been used. At one mine (*Coal Age*, May, 1951, p 100) such a drilling unit is fitted with a 42-in head, and one, two or three holes are drilled up the pitch to achieve the desired airway area. Drilling is done from crosscuts at the necessary intervals.

Shaft Sinking

SINKING METHODS may be influenced to a considerable degree by the type of shaft. Unless shafts are required rather frequently better results usually can be achieved by contracting their sinking, especially if they are large and deep, rather than by purchasing equipment and creating a staff of specialists. Surface facilities and sinking equipment, except for mucking, are substantially the same as in slope sinking, as mentioned. Lining materials, where required, include sprayed sand-cement and corrugated liner plates for circular openings, in addition to the standard timber, brick or concrete lining.

HEADFRAME UTILIZATION — It is possible to erect and use the final headframe for shaft sinking and lining purposes, though in deep major installations for coal hoisting it may be preferable to erect the headframe afterward. With air and escape shafts, the final headframe is much more easily installed in advance. In one instance the main sheave was centered over the inter shaft 260 ft deep for the sinking and lining operation. It then was moved to its final position over the escapeway half of the shaft to handle the cage.

MACHINE MUCKING — Muck may be loaded into a standard sinking bucket by hand, though in a multicompartment shaft where a heavy cage can be used in one compartment, new positive-act'on mucking machines mounted on the cage bottom may be employed (see May 1955, Engineering and Mining Journal, p 82, for example). Machines operating from tracks on the wall of the shaft also have been used to good effect in metallic and nonmetallic mines.

Where the depth is not too great, mucking may be done by a standard clamshell operating from the surface. And if access to the bottom of the shaft is possible, the muck can be dropped through a pilot drill hole into mine cars below.

Where shaft size is sufficient, overshot loaders or loaders of the tractor type speed up the process of getting the shot rock into the sinking buckets for hoisting. In one instance a tractor loader, with the diesel engine replaced by an electric motor, was used to sink a 15x38-ft shaft. Capacity of the unit was 1 cu yd. The rock was shot in 8-ft-deep rounds and then the loader was lowered into the shaft for mucking operation. Eventual depth of the shaft was 430 ft, and the concrete lining was poured as each round was loaded.

OUTLINING BY DRILLING — A new technique in sinking relatively shallow shafts — under 150 to 200 ft—is outlining the shaft by drill holes, using either an overburden drill or a standard borehole machine (*Coal Age*, April ,1955, p 74; June, 1958, p 106). One company, as an example, has put down six shafts up to 160 ft deep at savings of 50% of contract prices. These savings result from a minimum of manpower, simplified excavation and a solid shaft wall that needs a minimum of trimming, plus grouting additives to seal water off more quickly and positively.

Usual practice by the organization is to drill 8-in holes on 24-in centers on the circumference of a circle with a diameter 2 ft greater than the finished opening. Next, blastholes are drilled inside the shear holes. If the finished diameter is to be 12 ft, 10 holes are put down — one in the center and the others evenly around the 12-ft circle. The holes are filled with sand. To shoot a round, about 10 ft of sand is blown out and the holes are charged and fired. The muck is removed by a clamshell on the surface.

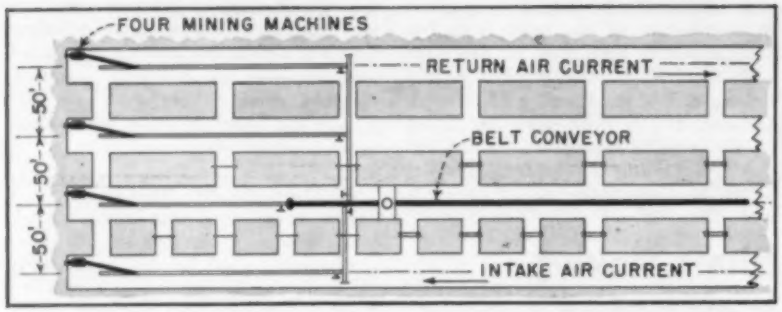
Cost of one such shaft was $289 per foot, as follows: drilling, $31; explosives, $8; mucking, $42; concreting, $108.

GROUT SEALING — Chemical additives now increase the effectiveness of grout in sealing off water quickly and positively. In one of the previously discussed shafts, pregrouting was done with chemical additive. After the blast and shear holes were completed grouting holes 10 ft apart were drilled in a circle 10 ft out from the shear holes. Diameter to bedrock was 10 in, in which 8-in casings were cemented. The holes then were extended down to the coal at a diameter of 6 in. The tops of the casings were fitted with 3-in pipe nipples.

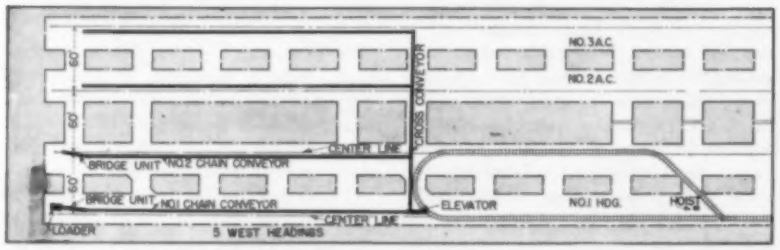
Grout with additive was placed in alternate holes and was forced into the strata by air from the regular drilling compressor. Ability to use such compressor equipment is one advantage of the system. On deeper holes, air sometimes may be dispensed with, since grout weight is sufficient to insure penetration.

GEL SEALING — New chemical gels and other materials that have the property of hardening in the presence of moisture and water are finding wider use in stopping seepage or sizeable inflow quickly. The materials are injected through drill holes ahead of and fanned

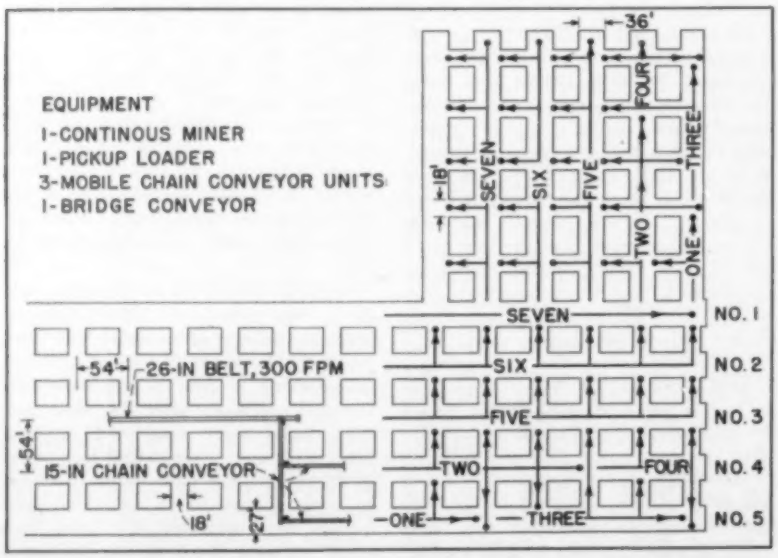
Development Planbook



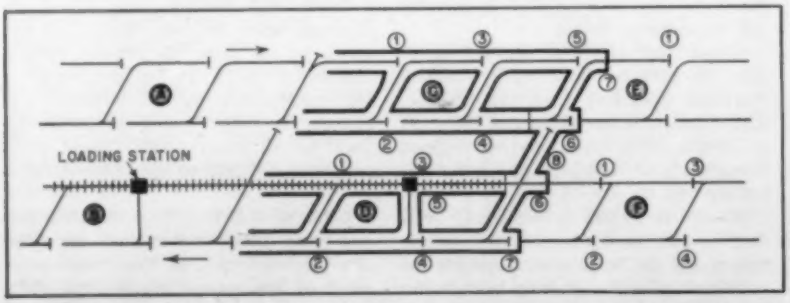
ENTRY-DEVELOPMENT PLAN with auger-head miner in 36-in coal.



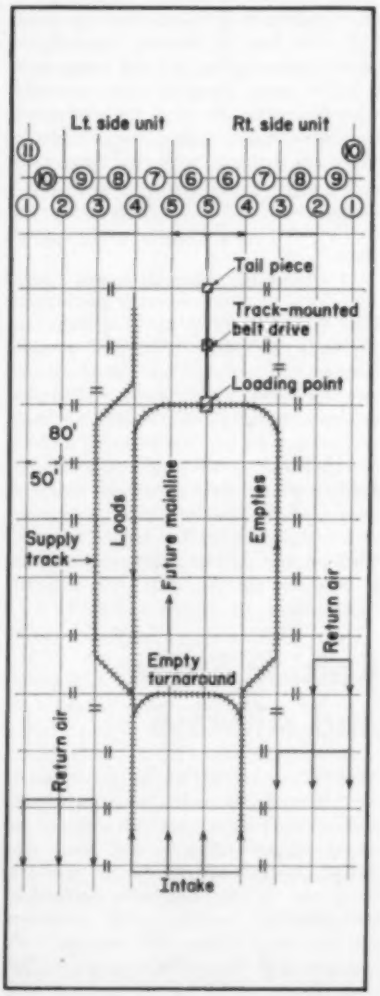
BRIDGE CONVEYOR-LOADER SETUP with loop track for cars is one of the entry-driving systems providing maximum advance with minimum cost. Cross conveyor brings coal from all four places to car-loading elevator.



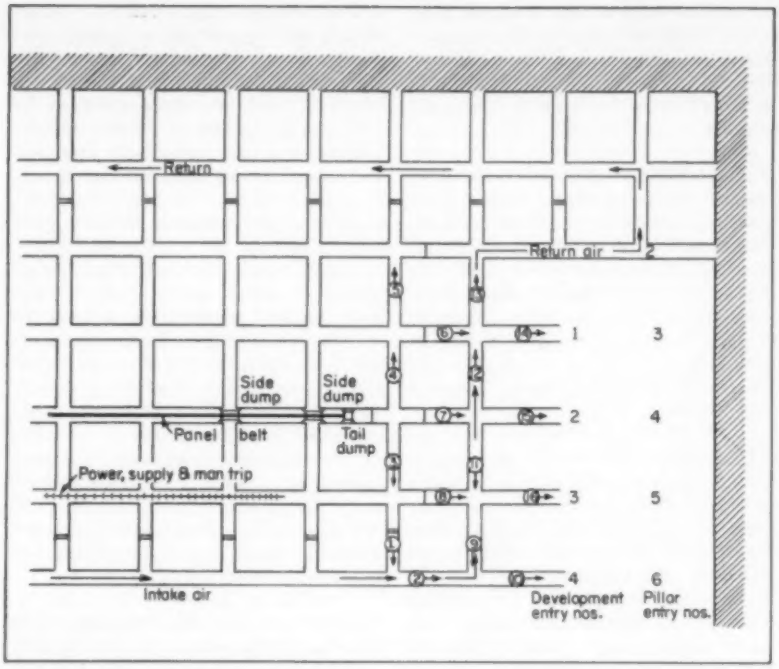
MINING PLAN with continuous miner, pickup loader, bridge and chain conveyors designed to keep moves to a minimum.

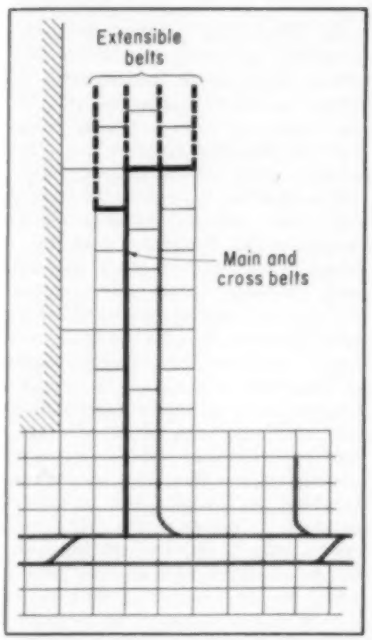


FOUR-HEADING MAIN ENTRY for development with boring-type continuous miner. Alternating from left to right the sequence of advance is shown by the letters and numbers. One objective is to keep shuttle-car tramming distance down.

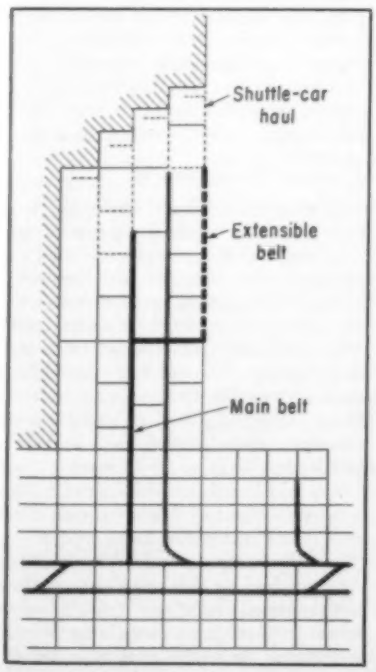


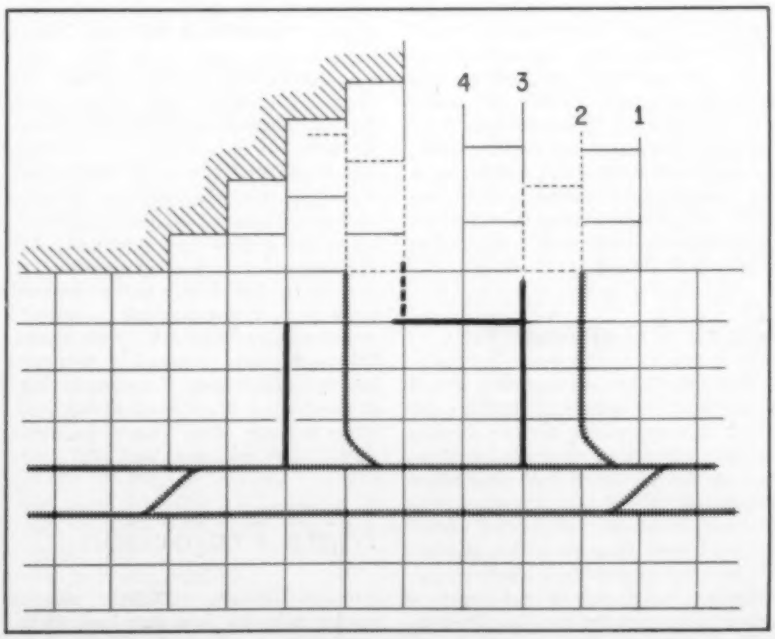
MAIN-ENTRY PLAN shows sequence of advancing headings with two continuous miners, track and belt setup, and ventilation.





FOUR-HEADING ROOM-ENTRY PLAN for boring-type miner with ropeframe conveyor. Four rows of pillars are removed on retreat.





FOUR MINERS served by single shuttle cars, extensible belts and cross belts develop four headings (upper left diagram) in this plan. In retreat (lower left diagram), since it is necessary to remove equipment when the roof starts to work, only one extensible belt is used and a second shuttle car or surge loader is used behind each machine. To change from pillaring to development of a new section (lower right) a spare main belt is installed to start the new panel, with a cross belt to permit completion of the old.

out to the side of the working face. Gel may also be injected after completion of shafts and slopes if water inflows continue or pop up after lining is done. In other words, the materials are quite versatile in application.

SIMPLIFIED LINING — Pouring of concrete linings for the preceding shafts was simplified by a special demountable form spread by a roof jack and held in place by wedges and bolts. In one instance, pipes were placed in four of the shear holes to carry concrete down to the form. After each pour, the pipes were shortened 7 ft. Using ready-mixed concrete, average time for a 7-ft pour was 30 min.

DRILLED SHAFTS — Drilling is finding increasing application as a means of sinking shafts for air and emergency purposes, as well as for men and materials. These drills operate on the coring principle, with the latest employing dry oil-well-type cutters on the drilling edges. With this latter machine, the entire drilling unit is lowered into the hole, along with the operator, and is hoisted to permit removing core sections. Its initial assignment (*Coal Age*, January, 1955, p 80) was drilling a 75-in hole 467 ft for a manshaft. The hoisting equipment for this shaft, incidentally, is of the so-called friction type.

The cost of one recent drilled shaft for ventilation at another property was $127 per foot, including $13.62 per foot for building the road to the site, grouting and other work in preparation for the main drilling job. Depth of the hole is 976 ft and the time required for the entire job, including preparation, was 6 mo, during much of which the weather was unfavorable. Diamond-drill holes were first put down to permit pressure grouting of the strata, and surface water was sealed off by drilling a 60-in hole 40 ft deep and concreting in a 54-in casing. This opened the way for drilling of the final 48-in hole.

Rock Tunneling

INITIAL CUT — In starting a rock tunnel from the outside, it may be possible, as in slope sinking, to use a dragline or some other type of excavator to go through the soft material. At some mines, this initial cut has been left open, with the sides stabilized by planting special ground covers. Spraying with a standard sand-cement mixture also has been successfully done to stabilize cut slopes. At others, a concrete section has been installed, as in slopes, and covered with excavated material. Cut-and-cover has the advantage that the material need not be hauled away, compensating in part for the cost of the lining.

TUNNELING EQUIPMENT — Even though not designed for such duty, coal equipment often is pressed into service where rock tunneling is a special job occurring only once in a great whole. The coal equipment, of course, includes loading machines and shuttle cars, and conveyors. As in slope sinking, a continuous miner may be employed if the material is predominately shale or other softer rock.

Where much rock tunneling is required, however, special rock facilities normally are employed. Rock machines include loaders similar to coal machines but designed for rock loading; also overshot-type loaders and slushers or scrapers of the 2- or 3-drum type, the latter providing a greater degree of flexibility in covering the entire face. The machines may load into rail cars, regular or rock-type shuttle cars or conveyors. Big (15-ton or better) shuttle cars and rock loaders are a popular combination in metal and non-metallic mining.

TUNNELING PERFORMANCE—In one 8 x 12-ft tunnel using a duckbill for loading, a crew for one shift was made up of a boss, three heading men and one loading-end man. Average performance was two rounds 6 ft deep every three shifts. Drilling time (two drifters on a bar) averaged 3½ hr per round, and loading time, 6¼ hr, including temporary timbering, advancing conveyer, etc.

In an 14 x 8-ft tunnel driven with a regular rock-loading machine, average performance was two 10-ft cuts per day of four 6-hr shifts. A four-man drilling and charging crew using two post-mounted drifters normally drilled and charged 26 holes in less than a shift. The cut then was completely mucked on the next shift by a 3-man crew. A ditch 5 ft at the top, 3 ft at the bottom and 3 ft deep was mucked by a hoe-type scraper working behind the rock loader.

In an 8 x 12-ft tunnel with 2 x 1-ft ditch on one side, drilling was done by a trackmounted double-arm jumbo and a car transfer was installed to facilitate switching cars behind the rock loader. The jumbo crew consisted of four men and the loading crew of 3 men. Average advance was 1 ft per hour. At this operation two or more places permitted shifting the machines back and forth.

Mine Projection

FULL-RETREAT MINING, meaning mining from the boundary back to the bottom or portal, is the ideal system, with exceptions so few as to be negligible.

ADVANCE AND RETREAT — One compromise providing results frequently as good as full retreat is advance on one side of the mine or working territory and retreat on the other to complete extraction. The basic principle is followed completely if full retreat is practiced in the individual working sections, though here again rooms may be mined on one side of a production entry on the advance, and on the other side on the retreat.

QUICK COAL — Other methods of providing coal while entries are being driven for a full or approximately full retreat system include setting off a special territory well protected by barriers near the bottom or portal, which can be mined, caved and abandoned without risk of affecting the permanent facilities. And where the coal outcrops along a hillside, quick production can be attained by moving in a shovel and stripping the outcrop, not only recovering coal in the stripping operation but also opening up the vein for augering or for deeper recovery by standard underground equipment, such as, a panel belt with loaders or continuous miners, shuttle cars and auxiliaries. If heavy rock or some other handicap makes true stripping undesirable, but conditions are such that benching is feasible and economical, augering or paneling still may be not only a help in development but also a source of considerable low-cost tonnage while the mine is getting started.

With the development of the mining-and-loading machine, the problem of going to full or near-full retreat in the thicker seams — and eventually in the thinner — is materially simplified. This results from the fact that the machine's rate of production is the same or almost the same as when working in rooms.

Contour Developments

In mining hilltops and knobs, the panel belt and other modern equipment permits economical recovery at a high rate of production, whereas such areas frequently were impossible to operate when everything had to be done underground. Now, the outcrop is opened by a bulldozer or shovel — the latter normally is required to make the necessary width of bench — and the coal is mined by all-conveyor units of the hand-loaded or self-loading types; by loading machines and shuttle cars feeding to mother conveyors or panel belts; by continuous miners and extensible belts, and so on. The belts in turn may feed to mine cars on track laid on the bench. As an alternative, especially where it is desired to work sections large enough to warrant a mainline belt, the coal may be discharged to a semiportable storage bin for trucking to the main plant. By erecting the bins in multiple, it is possible to store the full output of a second shift, for example, eliminating the need for

trucks and preparation facilities on that shift.

Section Setups

CLOSED V. OPEN PANELS — One question in setting up a mining section is whether to aim for complete isolation: in other words, a panel completely enclosed by pillars with no openings except for the panel headings. Considerations favoring complete closing of panels include: liability of the coal to spontaneous combustion, and the possibility of breaks in the roof to water-bearing strata. Closed panels facilitate sealing and damming where fires or water breaks occur. The closed panel also facilitates sealing to comply with legislation or the rulings of inspection departments.

Pillaring within a closed panel, however, is more difficult unless conditions are more favorable than those usually encountered. Therefore pillars frequently are left in place where panels are closed, though a number of operations recover them quite successfully.

Among the benefits of the panel system, whether completely closed or open, is ease in establishing splits for each individual working section. The panel system also lends itself somewhat better to the establishment of bleeder headings — a growing practice where gas emission is heavy and even where it is not for a general improvement in conditions.

PROVIDING BLEEDERS — Bleeder openings may be established in a number of ways. Examples are:

1. In room work on the advance, driving a place from the face of the first room, when it reaches full depth, back to the return of the main or cross entry from which the room entry was turned.

2. Driving a special bleeder entry and escapeway at the tops of room panels, or between panels turned toward each other, and cutting into it by extending the room entries, or by driving over to the bleeder from the faces of the first room or rooms to be completed.

3. Extending the first rooms to be completed to cut into a bleeder opening made by leaving the pillars in at the faces of the rooms in the preceding panel. As each room is cut into the old panel, the old pillar is included in the extraction routine to complete recovery.

Pillaring Practice

A second question in setting up a mining plan is whether to take pillars or leave them. Where the coal is thin, adding to the difficulty of mining, and the top is good enough so that pillar size may be cut down to a minimum, the tendency is to leave pillars. In contrast, pillars also are left in some thick-coal areas because of bad top. Basically, however, taking pillars, unless some special conditions prevent, is desirable to get full return on the necessary expenditures for entry-driving and other development operations. Leaving a third of the coal, for example, means driving, supporting, equipping and maintaining a third more room entries for a given tonnage.

PILLAR SIZE AND SHAPE — As a general rule, these are set by experience with the top, bottom and other natural conditions in the region, with another factor whether or not recovery is immediate. Aside from the weight question, square blocks and a standard width of opening everywhere result in uniform pillaring conditions all the time, thus tending to raise efficiency. Angle driving, yielding "diamond" pillars, substitutes, as a rule, 60-deg turns for 90. Both mine cars and shuttle cars are favored by these gentler turns, but ease of operation in other directions may dictate retention of the 90-deg principle.

Changes in equipment type also influence practice in sizing pillars. Thin pillars between rooms, for example, facilitate crosscutting and pillar extraction with bridge conveyors. Otherwise, after the reach of the bridge unit is exhausted, an auxiliary cross conveyor and drive would be necessary. Even without special equipment, thin pillars may be desirable for several reasons. To get maximum extraction in first mining, as an example, one operator reduces pillars to two-cut thickness. The final recovery step is slabbing one cut off the pillar and leaving the remainder.

Entry Driving

NUMBER OF OPENINGS becomes possibly the first question in developing an entry-driving program. In moderate to steeply pitching coal, the difficulties of developing under such conditions normally limit the number to two—a gangway for haulage and an airway above. At a fair number of collieries, gangways in coal have been given up for rock tunnels underneath the vein, though the airway still is made in the coal as a rule, with connections for ventilation and mining through rock chutes. In lighter-pitch coal, conditions are more favorable to increasing the number of openings, though the general practice still is to keep the number as close to two as possible.

The possibilities of both development and room work with continuous miners in coal under approximately 15 deg have been definitely proved in past few years. In one instance, where the inclination is 12 to 15 deg (*Coal Age*, August 1956, p 60), ripper-type machines driving gangways and counters across the pitch discharge to shaker conveyors. Rooms are necked from the lower gangway but with the exception of every third one, driven for ventilation, are not cut through until they are needed on retreat out of the panel. The coal is transferred from the shaker on the lower side of the gangway to cars on track laid in the center after the bottom is lifted for the requisite mining height. The mining plan used at this particular operation is included in the section on continuous mining in this 1958 Mining Guidebook.

WHY MORE HEADINGS — Among the factors involved in establishing the number of headings for an entry in flat-coal mining is airway area. In the thinner seams, especially if the air volume is expected to be large, driving additional openings to keep down velocity yields substantial savings throughout the life of the mine. But even after all the necessary openings for haulage, ventilation and man travel have been provided, it still may be desirable to increase the number. This is especially true with loading machines, and to a lesser extent with certain other equipment. The goal in increasing the number of headings is to make development work as near like room work as possible, which means the lowest cost.

WHY FEWER HEADINGS — The continuous miner and the bridge conveyor, among other new devices, are reducing the need for increasing number of headings for the sake of lowest face cost. A loader in two places equipped with bridge conveyors, for example, often can achieve higher tons per machine and per man, and thus a lower cost, than the same machine with conventional transportation in a considerably large number of places.

With continuous miners, the case is even more pointed since output normally is the same regardless of whether the opening is a room or heading.

ENTRY-DRIVING SETUPS—Equipment for entry driving in coal normally is the same in type and general method of use as in other coal work. With mine cars or shuttle cars, any convenient layout for track or transfer stations may be employed.

An example of an entry-driving plan with four headings is shown in an accompanying illustration (*Coal Age*, February, 1957, p 78). In this instance, the mining unit is a boring-type machine served by three shuttle cars, one a surge unit. Heading advancement is in a definite sequence, as shown by the letters and numbers. The basic plan is to advance the headings in pairs to keep tramming time to a minimum and also

keep to a minimum the number of crosscuts in the center pillar.

A second four-heading plan for a boring unit (*Coal Age*, March, 1958, p 74) is shown in another illustration. A ropeframe conveyor is used for transportation, and the sequence of cuts is shown by numbers. In retreat (see "Continuous Mining" section) the two rows of blocks from the previous development are picked up, and two rows on the opposite are left next to the solid coal to be picked up in the next stage.

A ten-heading plan for two continuous machines is shown in an accompanying diagram. In this instance, the crosscuts between the two center headings serve as the equalizers. If nine headings were driven, as an example, the center place could serve as the equalizer with two units operating.

With conveyors, whether loaded by hand or machine, some form of cross unit normally is necessary to bring the coal to one point, for transfer either to a mother belt or mine cars. One layout, based on bridge conveyors (*Coal Age*, September, 1954, p 106), is shown in the accompanying diagram. The cross conveyor brings all the coal to an elevator. Cars are loaded in trips on a loop track, with movement by a hoist.

A second conveyor layout illustrated shows a belt for panel haulage instead of cars.

Instead of the loop track, tail tracks for pushing in and pulling out are common in receiving coal for both conveyors and shuttle cars. Frequently, to get the necessary length of tail section, it is turned into a room or through a crosscut, with the elevator on the curve.

Keeping equipment moves to a minimum was one goal in another plan for boring-type continuous miners shown in an accompanying illustration. Arrows and legends show the sequence of advance. Rooms in this plan also are driven in similar fashion.

CROSSCUTTING ON PITCHES—The making of crosscuts between gangways and airways is one of the most costly and aggravating operations in developing for pitch mining. The big drill—36 or 42 in, or larger—has been suggested and used for this purpose (*Coal Age*, May, 1951, p 100). A new unit (*Coal Age*, August, 1955, p 58) is designed for pulling the big bit by a wire rope through a pilot hole, thus decreasing drill size and also weight to a few hundred pounds. One advantage of drilled crosscuts is the fact that they are small, though still large enough to carry the required volume of air. Consequently, they can be closed with a simple wood or steel disk, rather than an expensive custom-made stopping of the conventional type.

The Deep-Mining Guidebook . . .

Continuous Mining

Key Consideration

A production package—machines, methods, auxiliaries and manpower—matched to mine conditions and operated to provide the minimum in cost with complete safety.

Follow-Through

Development of a mining system matched to machine and mining conditions.

Use of trained men—operators and others—for high output and low maintenance.

Provision for nonstop coal transportation or its equivalent.

Auxiliaries with the necessary capacities to keep them from bottlenecking the miners.

Use of industrial-engineering principles to establish production standards.

Provision for output and other records, including delays, to keep close check on performance.

Roof support without hindering production.

Adequate ventilation for safety and good working conditions.

Rated voltage at the machine for efficient operation and fewer breakdowns.

Expert machine care to reduce production interruptions to a minimum and cut repair cost.

Supplies when needed to minimize production interruptions.

Safety always—not only for its own sake but for greater efficiency.

CONTINUOUS SYSTEMS—Among the basic considerations in developing a continuous-mining plan are:

1. **A layout which insures continuous or nearly continuous transportation availability.** If shuttle cars are used, for example, it is desirable to provide alternate routes to the transfer station to prevent interference. The changing point, of course, should be as close to the face as possible.

The extensible belt relaxes materially the limits on room depth and also eliminates the changeout problem encountered with wheeled transportation units. Thus, it makes possible special long-room panels, with room depths up to 1,000 ft or more.

2. **A layout which cuts equipment moves to a minimum—and keeps the distance down when such moves must be made.** The extensible belt, among other things, can, with the proper plan, cut the number and magnitude of moves, along with providing continuous transportation. Machine type also influences time spent in moving. Machines which drive full width, for example, need not be pulled back every 10 to 20 ft to widen the place.

3. **A layout which facilitates getting the necessary air to the working face and eases the dust problem.** A full discussion of systems and equipment for attaining these ends appears in the *Coal Age* Special Report, "The ABC's of Ventilation for Continuous Miners," February, 1959, p 97.

Examples of plans incorporating these three principles are featured in the "Continuous Mining Planbook" at the end of this section. A supplement shows various methods of mining individual pillars.

Square or nearly square blocks are becoming more and more the trend, and with it the use of flat or nearly flat pillar lines. Bleeder openings of one type or another are almost invariable practice.

Among the long-room and other "special" plans is the slabbing system under which rooms are driven by boring-type miners, after which the ribs are cut, shot and loaded with conventional loading machines.

Pitching Coal—With some variations depending upon machine type and

natural conditions, standard continuous miners can work up and down pitches of up to approximately 20 deg. Entries naturally are driven on the level and rooms are turned up pitch in usual fashion, except for perhaps some modification in centers to facilitate pillaring, if done. Of course, if the continuous miner is limited to entry-driving alone it can be used in coal pitching up to 90 deg. A new funnel-head machine has been specifically designed for such conditions (*Coal Age*, January, 1958, p 122).

Suggested plans for using continuous miners in coal pitching more than, say, 20 deg, include driving long places across the strike, using an extensible belt, and then drilling and shooting the up-pitch pillar, starting at the inby end of the place and using the miner as a loader in picking up the coal if it is of the type equipped with loading arms. Otherwise, a standard loader could be brought in for this phase of the work.

TRAINED MEN—This does not mean only formal courses or schooling, though these are growing in number and scope, particularly to meet the needs for maintenance and other special skills. But even without formal indoctrination, the alert supervisor, who will also be the better for training, can do much in instilling good work habits and a proper regard for safety.

NONSTOP TRANSPORTATION—As previously noted, transportation should be continuous or the equivalent of continuous for maximum output. The conveyor is theoretically the ideal from this standpoint, though shuttle cars give a good account of themselves with the proper mining system, and especially if a pickup loader or other surge facilities are employed. Auxiliary mobile conveyors are another development facilitating haulage with shuttle cars.

AUXILIARY CAPACITIES—Other auxiliary units, aside from transportation facilities, must also be matched to the miner to prevent bottlenecks—roof-bolters, for example.

PRODUCTION STANDARDS—Assuming a continuous miner with a rated capacity of 6 tpm will it produce that much every day? Obviously not, but there is a proper figure, which can be arrived at for all conditions by the application of industrial-engineering principles. Production standards established on this basis mean that it is possible to attain the maximum in efficiency. Savings of up to 25% or more in total mine cost have been achieved in this fashion.

PERFORMANCE RECORDS—The need for records will vary, but whatever the variation, the daily, weekly and monthly records finally decided upon should be detailed enough so that present performance can be compared with the past and with the performance of other sections, pits or departments—or better yet with engineered standards. Delay records are as important as production records, since they provide a basis for steps to avoid a recurrence.

ROOF SUPPORT—Aside from safety, the aim in support is installation without hampering production. Bolting units on miners are one answer. Alternating lifts with narrow-head units to permit timber advance in stages, as well as advance of curtains for ventilation, is another.

ADEQUATE VENTILATION—Because speed of advance increases gas emission and dust formation, positive means must be employed—brattice lines, auxiliary fans, etc.—to keep the face clear and gas and dust below the hazard levels. Yet too much air results in discomfort. Spraying and rock-dusting become much more important. Also, as a result of higher gas and dust formation, care must be taken to insure good rock-dusting in return airways.

RATED VOLTAGE—Voltage lower than the nameplate rating not only slows down equipment, particularly DC; it also breeds a don't-care attitude among crew members and results in more trouble and higher maintenance. Good voltage at the machine means good power—a vital factor in performance and cost today.

EXPERT MACHINE CARE—Low cost today depends on keeping machines running as much of the time as possible at rated capacity. Stoppages resulting from machine failures cost as much in idle time as any other interruption. Skilled preventive attention is the answer.

SUPPLIES WHEN NEEDED—Small breakdowns can have severe consequences when it is necessary to send to some distant point for a part that should have been in the production area. The moral is to make sure that supply items of the right type are at the right place at the time they are needed.

SAFETY ALWAYS—Last but by no means least in any set of principles for running a mine or section is constant emphasis on safety. The payoff comes from not only reduced accident costs but from the fact that safe methods are efficient methods—and safety-minded men are better producers.

Field Reports

Twin-Unit Development—Two ripper-type miners with pickup loaders and shuttle cars work together in advancing 10-heading entries. Crosscuts between center headings serve as the equalizers. Room panels feature bleeders and complete pillar extraction. *Coal Age*, April, 1958, p 86.

Boring Unit, Difficult Conditions—Low-type machine with shuttle cars recovers 43 in, leaving 7 in of top and bottom coal to stabilize bottom and prevent roof sloughing. Best tonnage per shift, seven face workers, was 400. Angle plan permits full utilization of mining head. *Coal Age*, June, 1958, p 86.

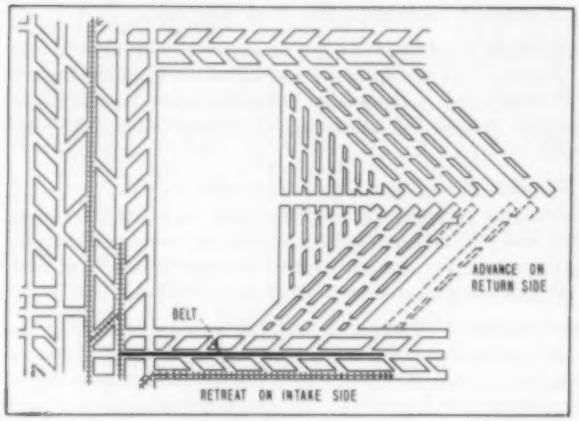
Boring and Ripping—Boring-type unit with shuttle cars develops and mines panels advancing on one side and retreating on other, averaging 57.5 tons of clean coal per faceman. Bolting makes for better roof control. Ripper-type machine recovers thin pillars and isolated blocks. Four-man crew averages 55 tons of clean coal each. *Coal Age*, October, 1958, p 92.

AC Continuous Mining—Full retreat alternating from side to side of the panel features AC operation using semirigid-head equipment. Pairs of rooms are driven 300 ft deep and pillars are removed immediately. Alternation takes place each time four rooms are completed. Shuttle cars feed to panel belts. *Coal Age*, November, 1958, p 78.

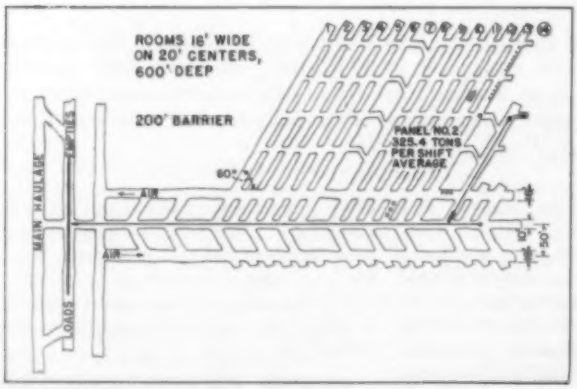
Highwall Operation—Productivity rate of 34 tons per man-shift achieved with boring machine and extensible belts in fingers left after stripping. Special system features flexibility in room depth and direction. Face labor cost is 70.3¢ per ton; bit cost, Ohio No. 8 coal, 4.7¢ per ton. *Coal Age*, February, 1959, p 104.

Full Pillaring With Boring-Type Equipment—Evolution in mining plan and transportation equipment in 96-in coal, with 7- or 7½-ft mining height, results in an increase from 376 to 621 tons per machine-shift in 34 mo. Final stages were adoption of flat pillar line and rope-frame conveyor. *Coal Age*, March, 1959, p 74.

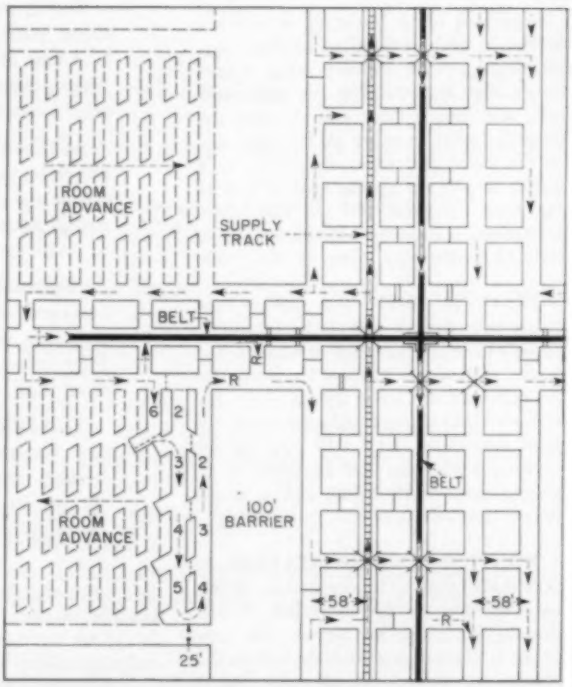
Continuous-Mining Planbook



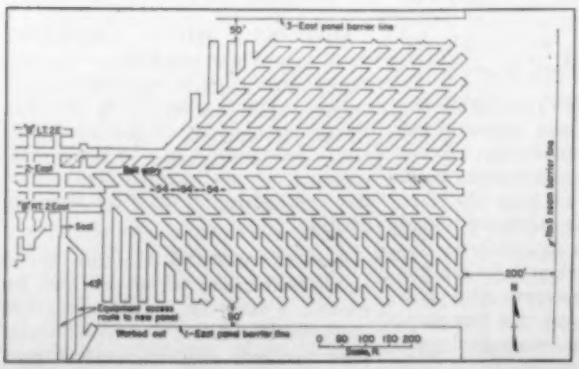
ANGLE PLAN with shuttle-car and belt haulage. Rooms are worked advancing on the return and retreat on the intake. Stub rooms are driven to mine the triangle formed in this project.



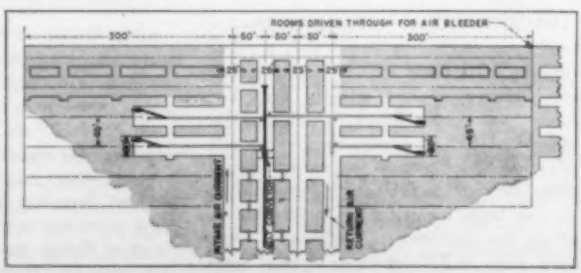
ANGLE PLAN with haulage by extensible belt, advance on one side and retreat on the other, ripper-type machines. Rooms are 600 ft deep.



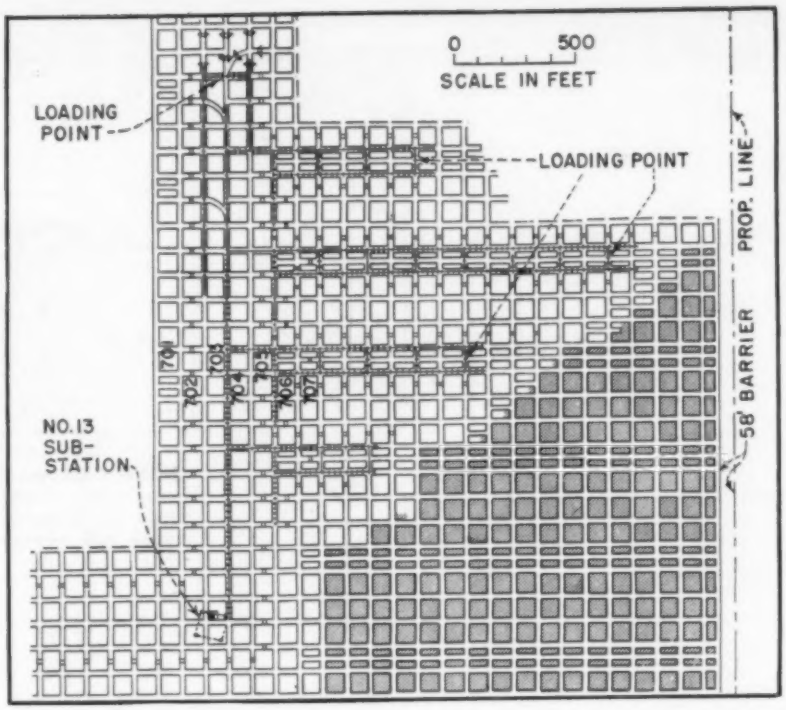
ADVANCE ON ONE SIDE of the panel and retreat on the other distinguishes this room plan for ripper-type units. The mining sequence in the first two rooms establishes the cross-cutting pattern for subsequent places.



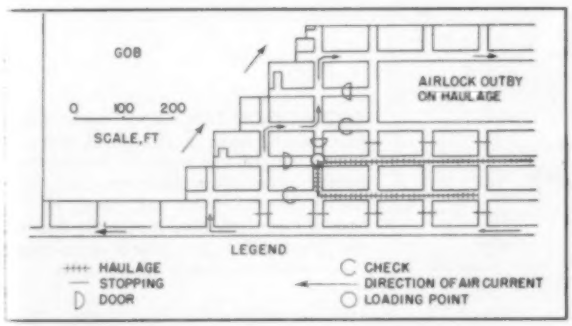
45-DEG TURNS permit full utilization of boring head. Rooms and pillars are mined on one side advancing, and on the opposite side retreating. Mining is always toward fresh air.



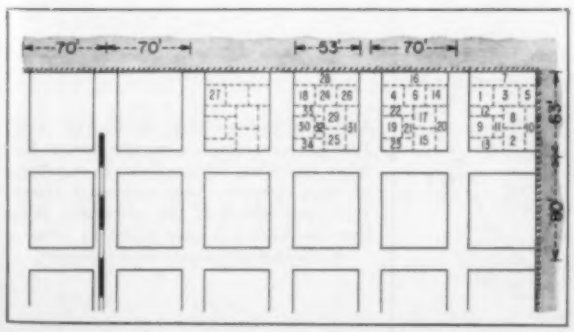
PLAN FOR AUGER-HEAD MINER shows full retreat after entry development. Machines on each side discharge to bridge and room conveyors. To increase recovery, rooms may be slabbed on the retreat.



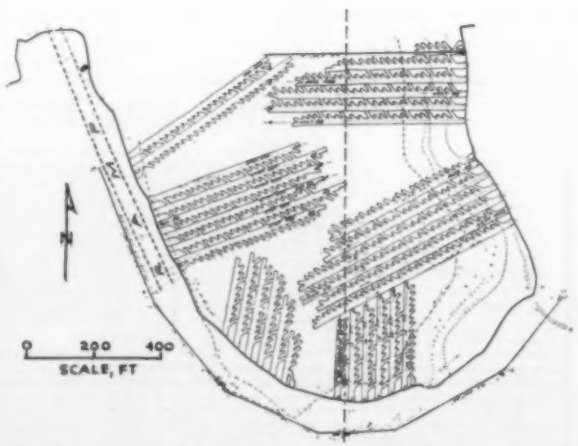
STEPPED PILLAR LINE—Long pillar lines are the exception rather than the rule, and where used frequently are stepped, as in this plan, each step constituting a section for a ripper-type unit. Loop-haulage system eliminates car-change delays at loading points.



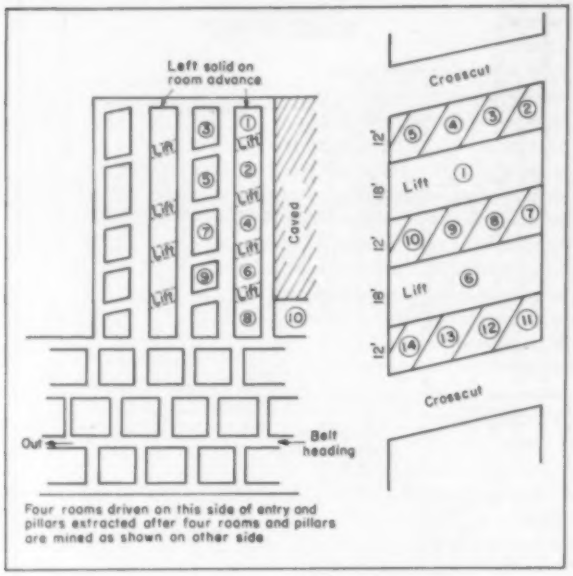
"SHORT-ROOM" PLAN for semirigid head machines employs rectangular pillars. There is little basic difference between development and room work in this system. Loop track facilitates haulage from shuttle cars.

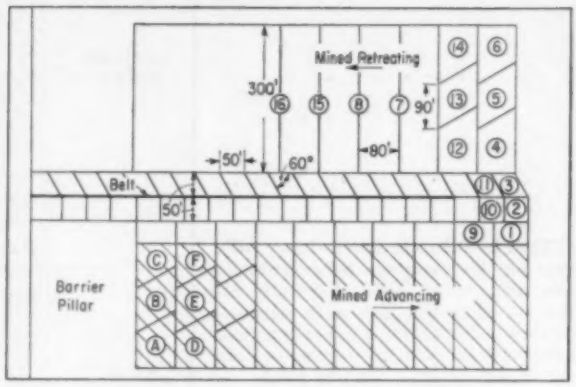


BARRIER RECOVERY PLAN (barriers 500 to 700 ft thick) with semirigid machine. The rectangular blocks are mined from two sides in the sequence shown.

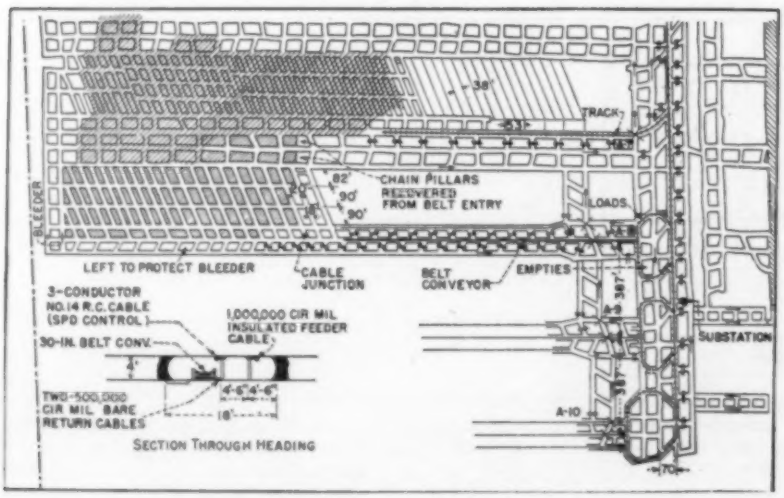


HIGHWALL PLAN for boring unit and extensible belt features flexibility in room direction and depth. Bad top requires careful support.

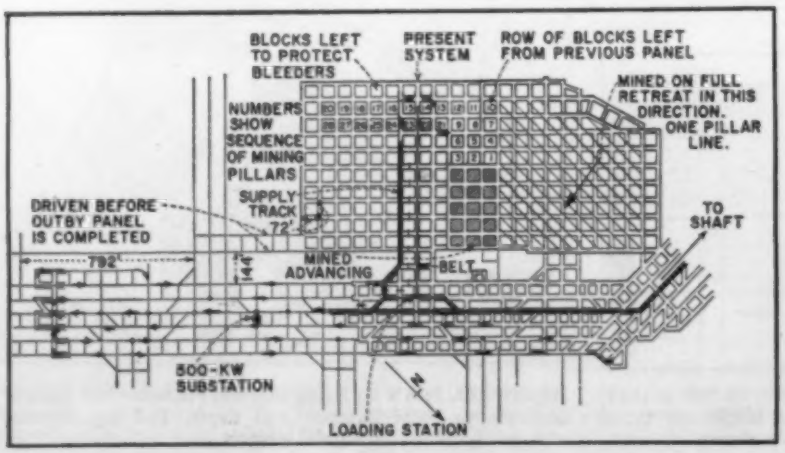

Left solid on room advance
Crosscut
Lift
Caved
Out
Belt heading
Crosscut
Four rooms driven on this side of entry and pillars extracted after four rooms and pillars are mined as shown on other side



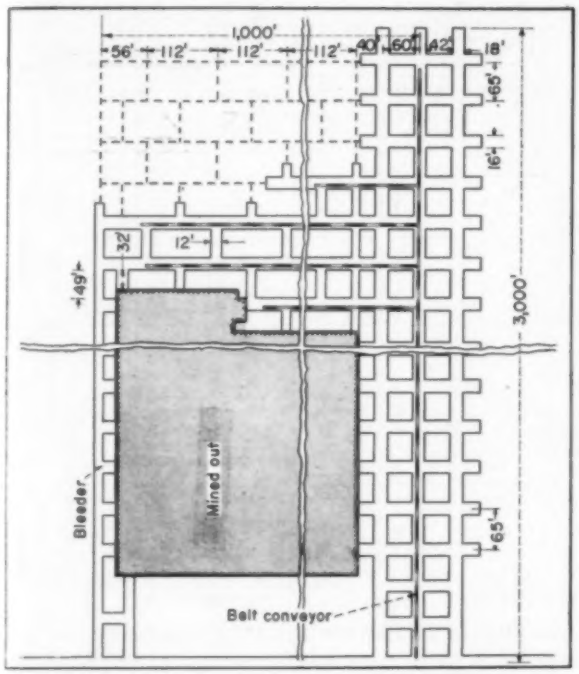
ANGLE CROSSCUT features these two plans, one for advance on one side and retreat on the other, and the other for retreat by alternating from side to side four-room groups. Letters and numbers show sequence of development and pillar removal.

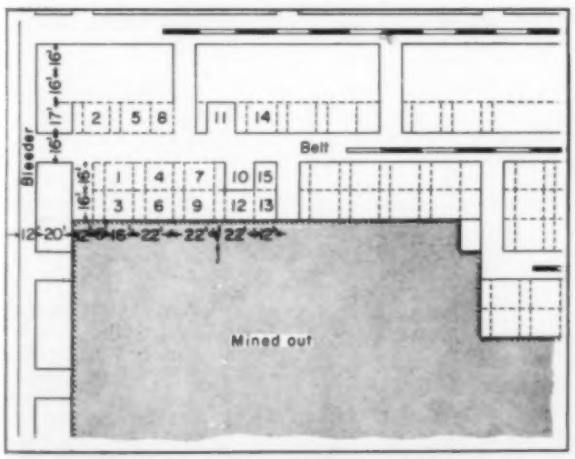


ANGLE DEVELOPMENT with rooms on only one side of the panel features this retreat-mining plan for boring-type miners in medium-thickness coal. The miner changes from one place to the next of two each time it reaches a crosscut. Thin pillars are mined open-ended when a room is completed.

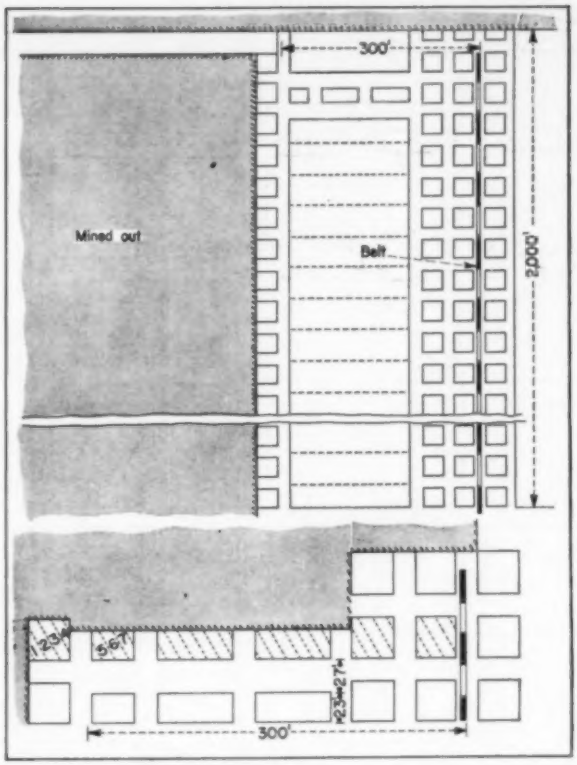


ADVANCE ON ONE SIDE OF THE PANEL and retreat on the other features this plan designed for a minimum of open territory. Two rooms are always kept open ahead of the advancing pillar line by driving a new place as soon as each line of pillars is completed.

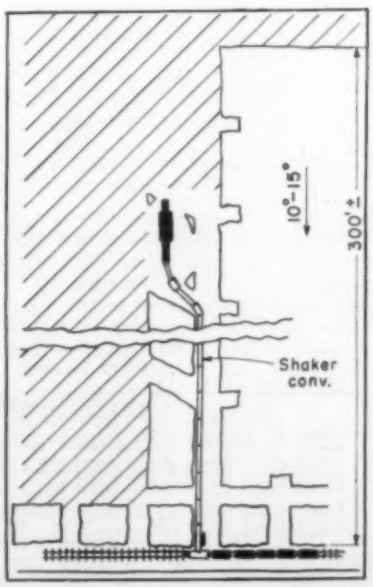




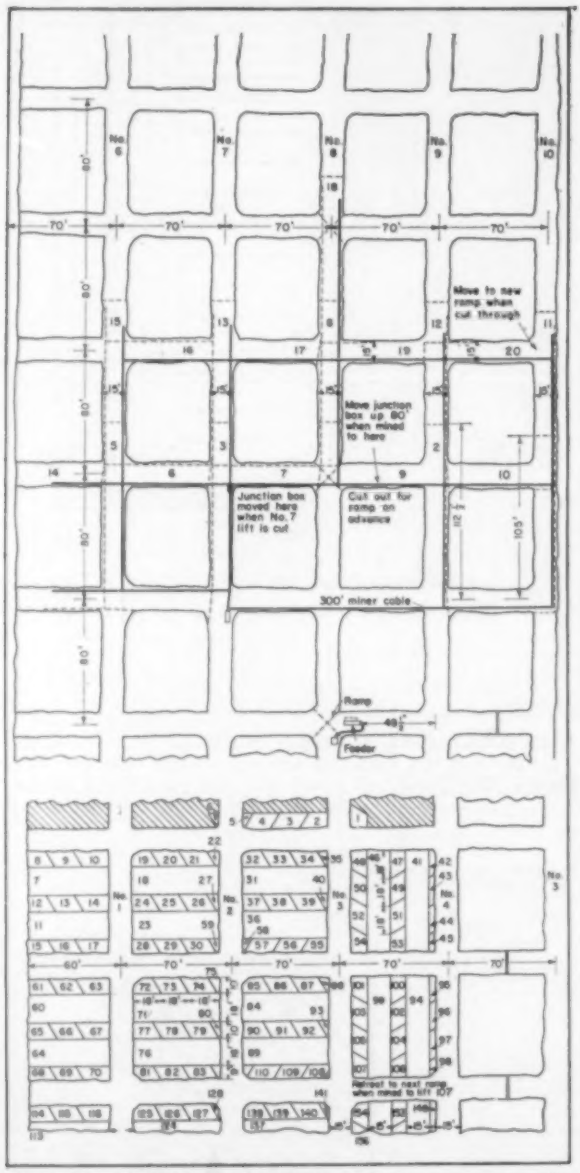
RIPPER-MACHINE PLAN for 66-in coal, sections 2,000 ft wide and 3,000 ft deep, mined advance and retreat. Alternate right- and left-hand pillar extraction is practiced, with pockets driven as in the view below to complete recovery. The miners discharge to extensible belts equipped with bridge conveyor. Coal recovery is about 90%, and good pillar falls are secured.



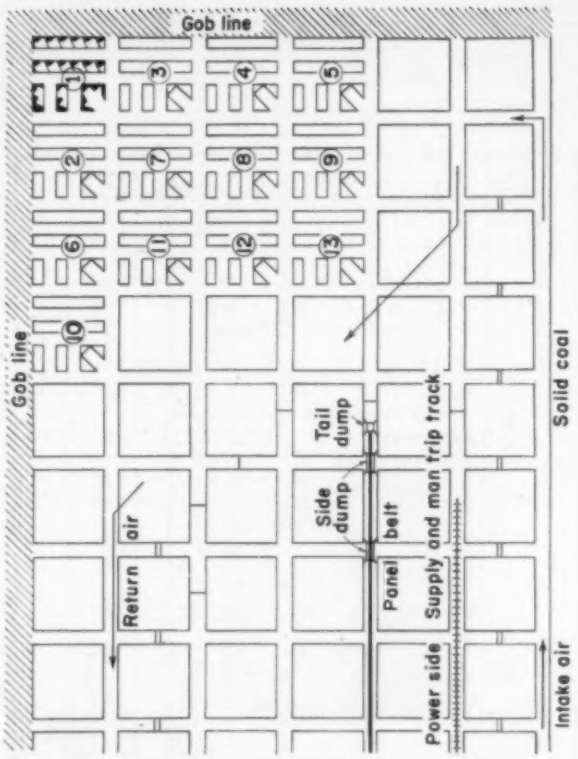
ANGLE-PILLARING PLAN for boring-type miners in 40-in coal. The first two rooms are driven abreast to establish ventilation. Then rooms are driven and pillars are mined on the angle as shown.



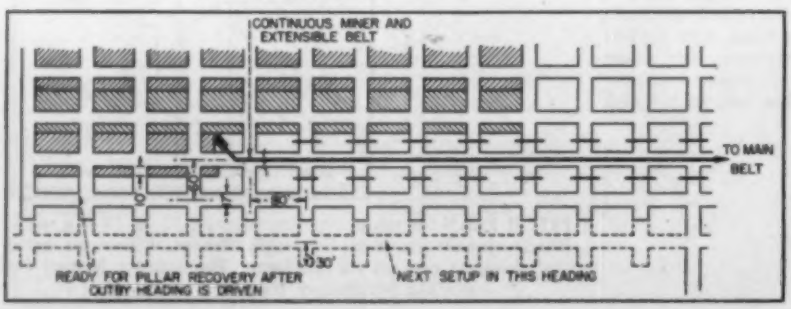
PITCH PLAN for ripper-type machines in 12- to 15-deg work. Blind crosscuts are used for supply storage. Conveyors bring coal down to cars on the gangway. The counter is used for miner travel.


Move to new ramp when cut through
Move junction box up 80' when mined to here
Junction box moved here when No. 7 lift is cut
Cut out for ramp on advance
300' miner cable
Ramp
Feeder
Retreat to next ramp when mined to lift 107

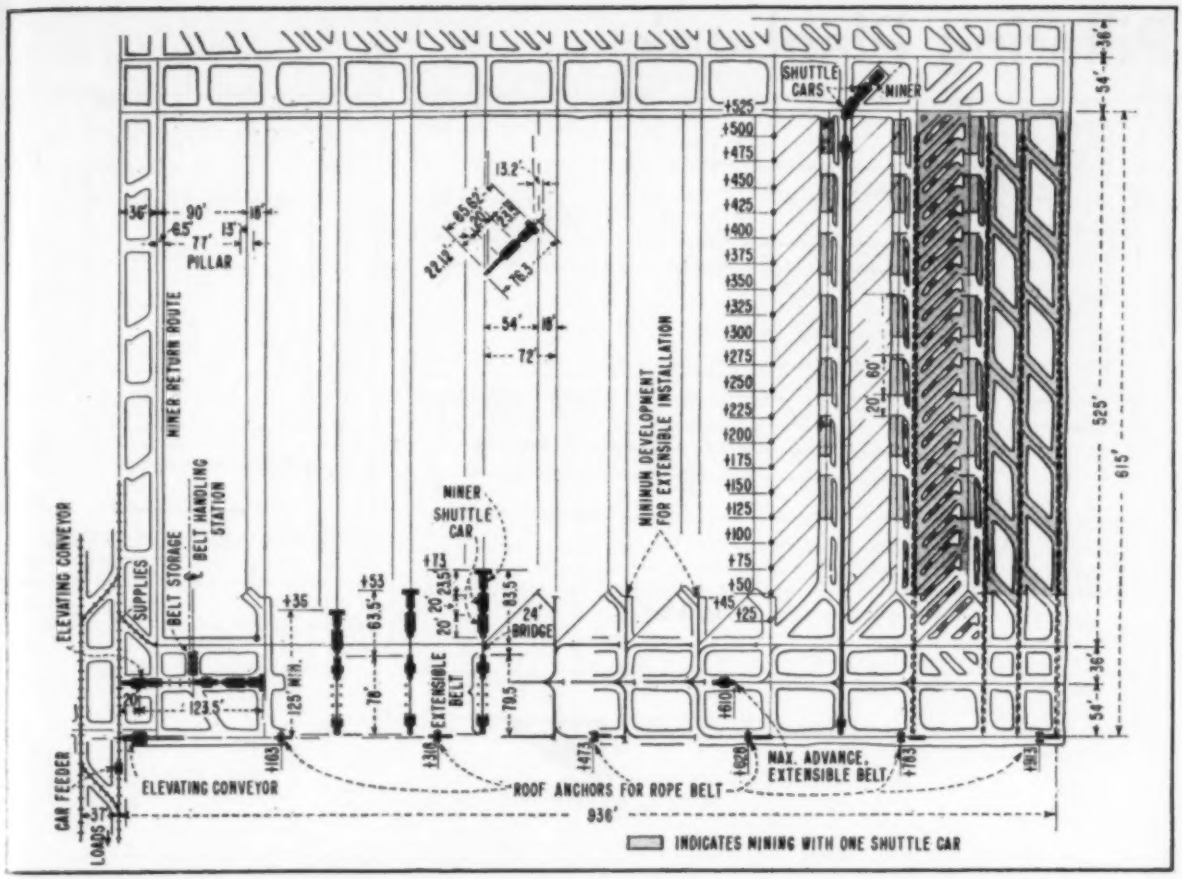
KEEPING EQUIPMENT MOVES DOWN was a major objective in this mining plan for thick coal and ripper-type machines with shuttle-car service. Strict adherence to driving sequence limits equipment moves. Pillars are removed one at a time by 18-ft lifts leaving 10-ft fenders. Bolting units are mounted on the miners. Average output is 43.6 tons of clean coal per faceman.



INDIVIDUAL PILLAR RECOVERY on a flat line features this plan for a boring machine with shuttle cars hauling to an extensible belt. Pillar removal sequence is shown in diagram in the "Pillaring Planbook."

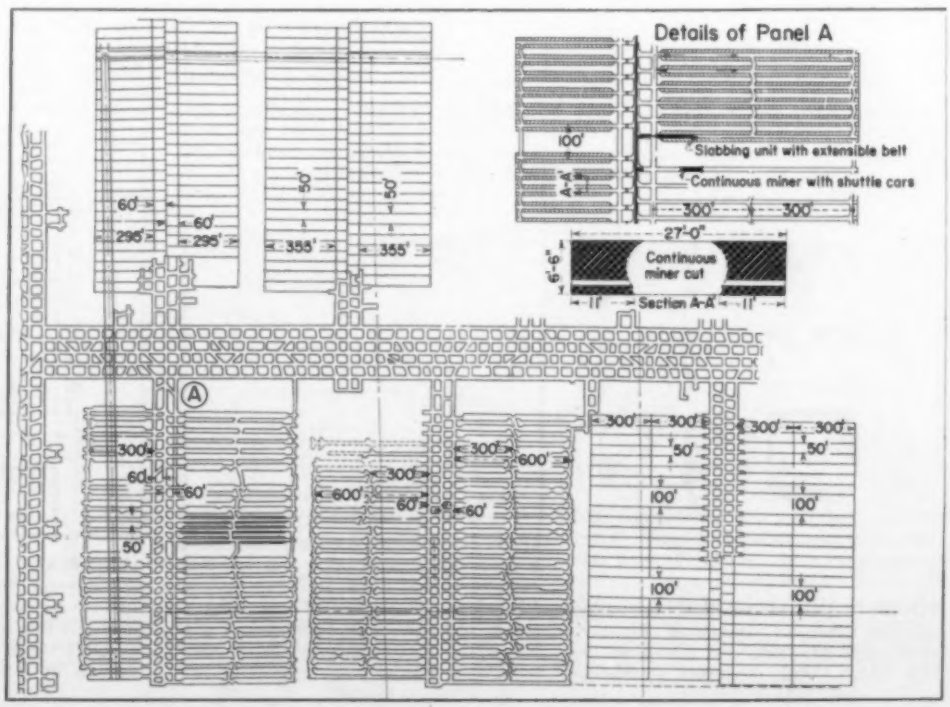

CONTINUOUS MINER AND EXTENSIBLE BELT
TO MAIN BELT
80'
30'
READY FOR PILLAR RECOVERY AFTER OUTBY HEADING IS DRIVEN
NEXT SETUP IN THIS HEADING

EXTENSIBLE BELT PLAN for ripper-type miners permits driving places 1,000 ft deep. When the place is driven the miner takes 10 ft off the pillar on the solid side and then completes the pillar on the gob side. When extraction is completed, the miner leapfrogs the next place (already driven) and drives up the third one. Miner and head and tail sections of the belt then return to complete No. 2, in which extra belt and stands are in place.

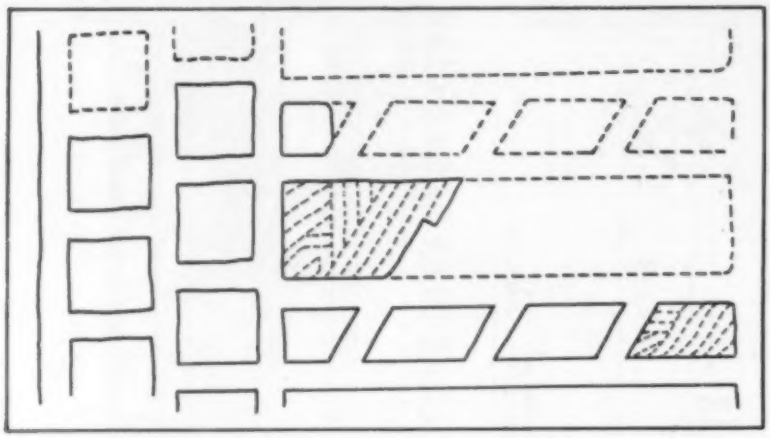


MINING WITH BORING-TYPE UNIT and rope-type belt in 525-ft rooms, thick coal. Pairs of rooms are driven on short centers and pillars between pairs are mined by angle lifts. Chain pillars are recovered with two shuttle cars.

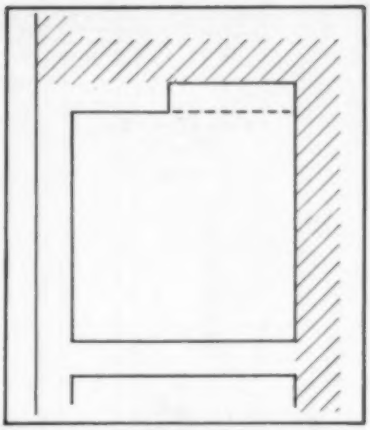
SLABBING PLAN uses extensible belts with boring-type miners to drive 600-ft rooms with one crosscut halfway up and another at end, using blowers. After miner moves, room is center cut 11 ft deep on both sides, and the coal is shot and placed on belt by crawler loader.



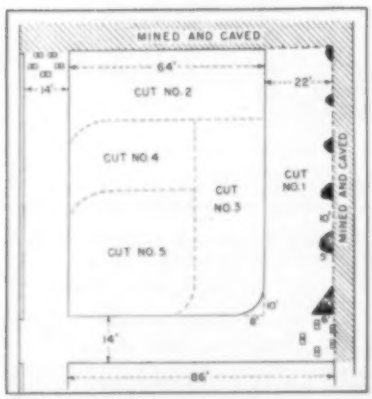
Pillaring Planbook

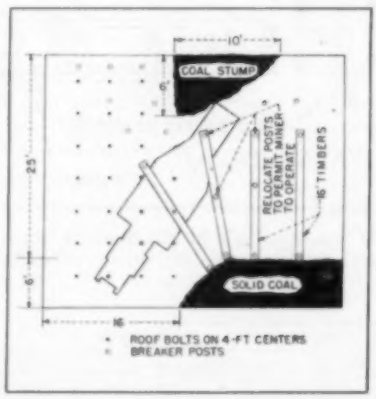


ANGLE OPEN-ENDING combined with 90-deg development. Top is medium hard and places are driven 16 ft wide on 50-ft centers with boring-type miner. Solid pillars between pairs of rooms provide much of the tonnage. Angling favors the boring-type continuous machines.

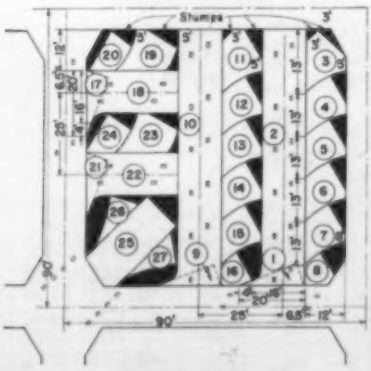


CONVENTIONAL OPEN-ENDING is one of several types employed in continuous mining and is facilitated by speed of extraction, in turn easing the support problem. Simplicity is another feature, not only in mining but in ventilation and moving of equipment.

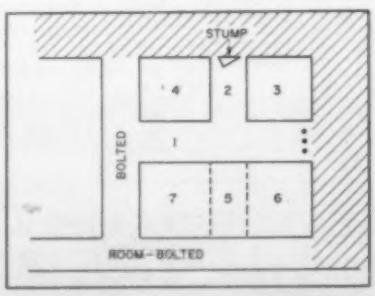




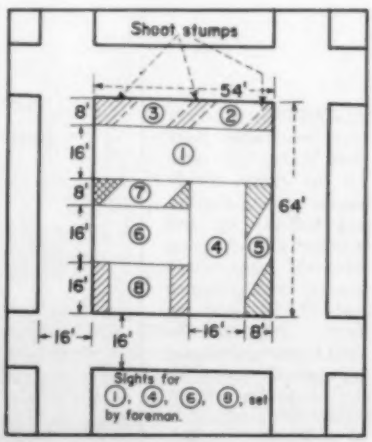
OPEN-ENDING WITH SMALL COAL STUMPS for additional support and protection of the lift across the pillar. The stumps supplement roof bolts and crossbars placed as in the right-hand diagram. Ripping-type machines are employed for the mining operation in thick coal with a drawslate top.



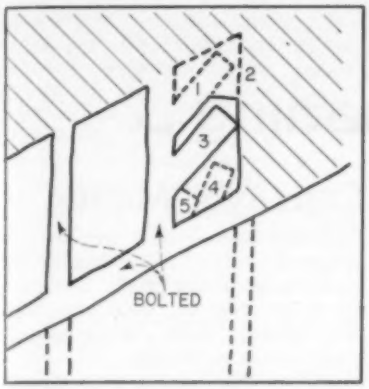
POCKET- AND WING-PLAN for boring machine shortens tramming distance, eases cable handling, cuts mining on the butt cleats, and facilitates shuttle-car haulage.

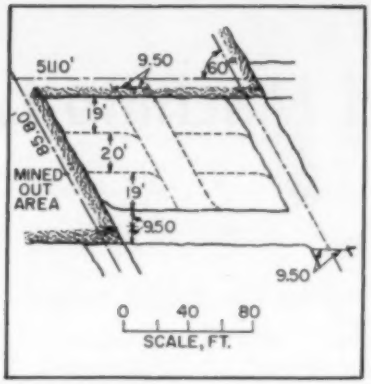


SPLITTING in its various modifications is a popular form of pillar removal. Normally it provides the maximum in coal for holding weight until final wing or stump removal. This conventional plan leaves big corner stumps plus a small triangle in the secondary split for protection.

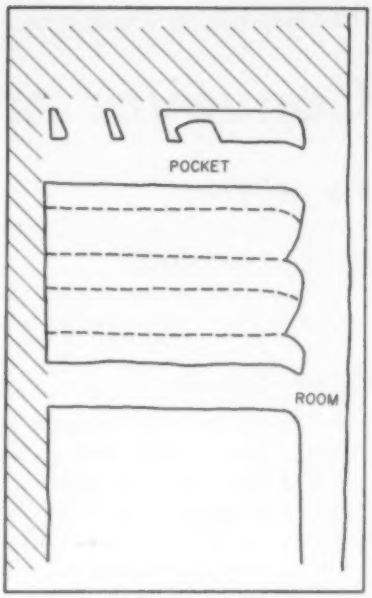


ALTERNATE LIFTS are taken from two sides of the pillar in this plan for ripper-type machines in thick coal with drawslate top, roof-bolters on the miners. The 8-ft wings are removed by cutting through at intervals and shooting the stumps.

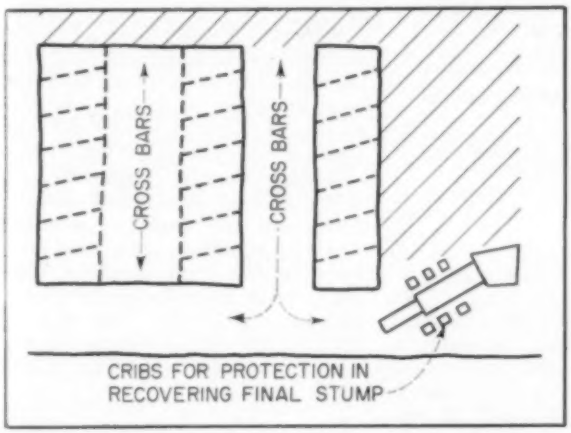




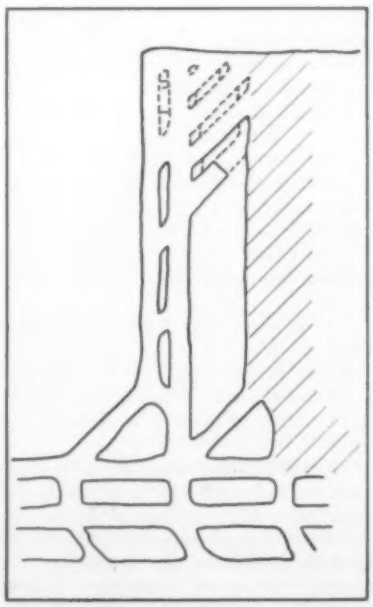
SPLITTING PLANS FOR DIAMOND-SHAPED BLOCKS. Left view shows 60x70-ft blocks, 4- to 6-ft coal, firm shale top, boring-type miners. Fast extraction permits recovering two halves with posts only. Right view, semirigid machines, shows splitting on shorter axis recovering halves open-ended. Square blocks also can be mined with similar plans.



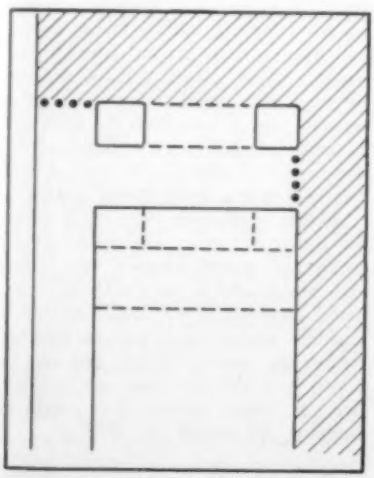
WINGS in this pocket plan for ripper-type machines are formed in 85x85-ft blocks by driving places 15 ft wide to leave wings 10 ft thick. These are cut through at intervals to leave small stumps. Roof is top coal and drawslate held by bolting.



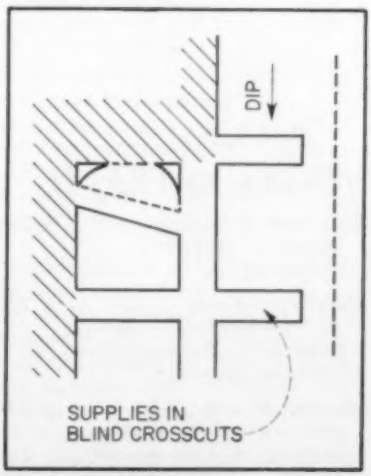
WINGS ARE OPEN-ENDED in this splitting plan for drawslate. Semirigid miners are employed. Bars in splits are held at the gob end by bolts and, at the solid side, by posts, which remain and act as breakers when the next split is mined. Limiting posts to only one row also reduces interference. Cribs are set on each side of the miner in taking the final pillar lift.



ANGLE POCKETS with thin fenders rather than thicker wings distinguish this plan of mining. Basic development with boring-type equipment is on 90 deg. Rooms are driven in pairs and the thick pillars between pairs are removed by subsidiary pockets. The final operation is splitting the chain pillars and fenders, as shown.



POCKET PLAN of the conventional type includes wings which are split to leave final stumps.



SLANT POCKET is employed in pitch-mining plan with ripper-type machines. Final extraction involves splitting wing on the upper side. Inclination is 12 to 15 deg.

Conveyor and Machine Loading

Starting Points

Use of the highest-capacity equipment available for the conditions at the property.

Maximum production per unit and per man through modern mining plans and operating practices.

Follow-Through

Careful study of available equipment types and installation of the highest-capacity units matching mine conditions.

Emphasis on the development of mining systems that will provide an opportunity for the equipment to produce at as near maximum rate as possible the entire shift.

Providing the loading unit with supplementary units of the proper capacity to prevent bottlenecking and delays to the loading operation.

Achieving a cycle properly balanced in all its elements, this also to prevent bottlenecking and delays.

Equipment Selection

MOBILE EQUIPMENT, since it is inherently higher in unit capacity and thus more economical of labor, ranks first in choice among available types of loading units. Loaders now are available for operation in coal as thin as 3 ft or slightly less. Matching auxiliaries include the articulated shuttle car as well as the extensible belt, both tending to further increase the productivity of the face unit. Very-soft bottom is one of the few possible bars to the use of mobile equipment.

At the other end of the scale loading machines with extra-high capacity, and with auxiliaries designed for the job, have been made available for mining up to 15 ft or more in coal height.

CONVEYORS—Under 36 in and almost certainly under 30 in at the present time, practicable mechanical devices are conveyors and scrapers, the former being preferred. Self-loading heads on the shaking types of conveyors convert them into true loading units.

PITCHING COAL—Conventional conveyor and mobile equipment can be used with a high degree of efficiency up to approximately 18 to 20 deg. At 10 deg or less there is only a slight difference in results, if any. Where haulage is concerned, the breaking point where conveyors usually must be substituted for rail cars or shuttle cars usually is around 5 deg. However, rubber-tired equipment has been used in crosspitch rooms or chambers to around 12 deg. The maximum pitch on which mobile machines may be employed is yet to be determined though up to 18 to 20 deg has been achieved.

Explosives and gravity remain the major production tools where greater than sheet iron pitches are encountered. To make it possible to bring these forces into play with a minimum of labor the longhole drill is being increasingly used.

Where to Find It

Equipment Selection . . . . . p 222
Thin coal . . . Thick coal . . . Pitching coal

Conveyor Mining . . . . . p 222
Cutting moving time . . . Conveyor projections . . . Unit organizations . . . Scheduling face work

Machine Mining . . . . . p 224
Machine projections and plans . . . Shuttle-car, track and conveyor haulage . . . Pillaring systems

Pitch Mining . . . . . p 230
Light pitch . . . Moderate pitch . . . Heavy pitch . . . Longholing . . . Boring crosscuts

Conveyor Mining

CONVEYORS normally are used in groups of two to four, although the variations are almost infinite. The benefits of grouping are those usual with concentration. Single conveyors are found mostly in pitching coal, and in second or third mining of anthracite. And whether single or multiple, in rooms or in entries, conveyors usually discharge either to a panel belt or to a gathering or cross conveyor concentrating the output at a single car-loading point.

Without a flexible joint or a face unit, practicable room width with hard loading usually is 16 to 18 ft. With face units, rooms can be driven 50 ft, 60 ft or more in width where roof and other condition are favorable. Wider faces ease the problem of arranging the cycle so that loading proceeds with minimum interference and maximum efficiency. And even though the face conveyor is longer, putting it on wheels or rollers and designing the joints for quick breaking and making (*Coal Age*, October, 1952, p 77, for an example) permits rapid moving even where close timbering is necessary.

SWIVEL AND TURNS—With shaker conveyors, swivels make it possible to swing the face end rather steadily, provided jacks and posts do not interfere. Thus, within limits it is possible to widen the place without going to face units or turning the trough. At the same time it is possible to keep the face end of the conveyor in the most favorable position for hand loading. Ability to use swivels and turns permits driving crosscuts and working pillar places without separate drives. Bellcranks also permit operating separate trough lines from the main unit as desired. Uphill types with curved discharge chutes also can lift coal or rock and load it into cars without auxiliaries.

Adding a duckbill or sawbill makes the shaker conveyor self-loading. Power swing and power advance and retract also are available on duckbills. Compared to loading by hand, adding a duckbill, sawbill or power duckbill increases the number of cuts that can be mined in a shift by from one to three, thus, in some instances, as much as doubling the output per shift.

Cutting Moving Time

One of the biggest headaches in the use of conveyors of the conventional

type is not only extension time but also moving time. Though there are not too many, some methods for saving in moving time do exist. As previously noted, equipping face conveyors with rollers is one. Couplings that are quick to lock and unlock, and special tools for breaking and joining chains are among them.

The time-consuming and costly job of moving from one place to another can be materially eased by at least certain steps, including the following:

1. Turning the moving job over to special crews.

2. Using pullers and carriers to eliminate most of the physical effort and much of the time involved in shifts from one place to another. Shortwell trucks of the crawler or rubber-tired types can be used for carrying or towing or both. Or pullers and carriers specially designed for the job, including the necessary winches, may be purchased or made.

3. Using mobile drive sections. These mobile sections, mounted on crawlers, have made it possible to move an entire room unit completely in as little as 1½ hr.

MODIFIED MINING PLANS—Certain mining systems help in cutting down on charges for moving conveyor parts and such materials as crossbars and the like. If only one place is worked at a time, as an example, blind cross cuts may be driven toward the next place, and pans, chain and materials may be stored in them for pickup as the new place comes up to the crosscuts. Or, the conveyor line may be left intact in the old place to permit pans to be taken off as needed and moved through the crosscuts.

Special mining pans designed to reduce moving time include the "continuous-room" setup shown in the Planbook later in this feature. One place, it will be noted, serves as a beltway with a cross unit bringing the coal over from the others. When the "rooms" have advanced the set distance, another cross unit is installed after the drives for the room conveyors have been moved up. Moves thus are made straight ahead and over a minimum of distance, reducing the time requirements.

"Panning up," or conveyor extension, when done section by section, interrupts face operations and requires both time and labor. The bridge conveyor is one method of reducing the number of interruptions and the time required. In fact, the first bridge unit was developed to reproduce pan-up time in hand loading, but was quickly adapted to carrying coal away from loaders and continuous miners because of its manifest advantages.

Field Reports

High Tonnage in 36- to 48-In Coal—New high-capacity low-vein loaders served by shuttle cars and ropeframe conveyors handle bulk of output at two new mines developed with 8-heading mains and 5-heading panel entries. Panels are worked against the air—advancing on the return side and retreating on the intake. *Coal Age,* June, 1958, p 78.

Mining "Nonminable" Seam—Belt conveyors and other modern auxiliaries permit operation in spite of grades and other adverse conditions. Loader-shuttle car units with 10-man crews mine 60-in seam with 8-in parting, using air for breaking. *Coal Age,* December, 1958, p 78.

High-Tonnage Punch Mining—Mines approximately 5,000 ft wide along outcrop and 7,200 ft deep, providing around 3,000,000 tons of coal, worked with track, section belts and loader-shuttle car units. Coal thickness is 42 in and 51 men on payroll, two shifts, account for 1,224 tons. *Coal Age,* January, 1959, p 104.

Efficiency in Thin Seam—Loader-shuttle car units, with air breaking average 16 cuts, or 445 tons, per shift with 11-man crews in 46-in coal. Section belts are preceded by portable grizzlies. Blocks are split on retreat. *Coal Age,* May, 1959, p 70.

Conveyor Plans

The plans adopted for conveyor mining are as numerous as the variations in equipment units, but the most-used ones are two:

1. Driving the room entry up the full distance and then working rooms on one or both sides on the retreat. If the mining is done on both sides of the panel, one equipment unit may alternate, or matching units may be used on both sides (see auger-head mining plan in the Continuous Mining Planbook). The conveyor layout is typical of those used with hand or machine loading.

Where the coal pitches and entries or gangways are driven on the strike, places are turned up the pitch. Occasionally (see Mechanical Mining Planbook later in this feature) a subopening may be established up the pitch to permit two or more groups to be operated in cascade fashion. A variation is driving stubs up the pitch, equipping them with proper lowering equipment, then turning rooms across the pitch starting at the top of the stub and working down.

2. Developing the room entry and at the same time working rooms on one side of the advance, then completing the panel by retreat on the opposite side, is another common conveyor system. This normally results in a more even output rate over the life of the section, and also keeps all working sections on the fresh-air side of the panel ventilating system. In driving and advancing on one side, the entry, as shown in the accompanying plan (see Planbook), may be advanced a certain distance and then the equipment moved into the rooms to mine them out, after which another entry advance is made.

In any system, most operators like to prepare room necks in advance. Thus, if the entry is completely developed in advance, places may be necked 2 to 3 cuts on one or both sides to be ready for final mining—that is, with a two-heading entry. However, if chain-pillar crosscuts are made on room centers necking may be unnecessary on one side. And with a three-heading entry, with the belt in the center, crosscutting on room centers can eliminate any necking on either side, though many operators still feel that it is worth driving in to the point where room widening starts. Also crosscutting on such short centers may be undesirable from several standpoints, including extra stopings and more likelihood of roof trouble.

PILLAR EXTRACTION—Where the coal is under 3 or 3½ ft and the top permits, many operators prefer to reduce pillars to a minimum and leave them, some arguing that the value of the coal left is less than the cost of the timber that would have to be put in to recover it. In at least one instance part of the pillar is pocketed out and the remainder left to protect the next pocket, eventually crushing with subsidence of the top. Where pillars are taken, usual practice is to widen to one side only, putting the conveyor along the straight rib where it is close to the pillars to be removed.

Unit Organization

In addition to the room and—possibly—face and cross conveyors and elevators the usual practice in setting up a con-

veyor unit is to put a shortwall cutter and a drill in each place. Attempts to move cutters from place to place make it difficult to set up a tight face cycle, which is essential for maximum efficiency. Drills may be separate, each with its own cable, though a common practice is to plug drills into cutting machine takeoffs.

Flexible-shaft drills, likewise operating from cutter takeoffs, have made major strides in conveyor and other mining in recent years, as has the hydraulic hand-held drill powered either from the hydraulic system on the cutter or, if the cutter has no hydraulic facilities, from a special hydraulic portable pump.

Other equipment frequently found in a conveyor setup includes specially designed rockdusters and bolting units.

SUPPLYING CONVEYOR UNIT — Supply-handling equipment includes wheeled dollies operating in pan lines, and small hand or powered winches to pull timber and other heavy materials up to the face. In cross-pitch rooms, a plank roadway on which a wheeled dolly runs may be built to deliver materials from a hoist in the slope or chute opening.

The false pan line is a simple and effective alternative in flat or mildly pitching coal. Until the halfway point of the place is reached, a false line is built alongside the regular line by pulling it forward and attaching a section each time the regular conveyor is extended. Each new false pan is loaded with enough supplies to take care of that much advance of the face, and the line is pulled up by the cutter so that the inby pan can be unloaded and added to the regular line. When the last section of the false line is pulled up, the room is completed.

Outby the rooms, supplies may be brought in by rail trucks, by rubber-tired equipment or by reversing the panel belt. Some belts have been fitted with jogging and inching controls for this purpose (*Coal Age*, April, 1946, p 86).

Scheduling Face Work

The usual face crew, whether loading by hand or power, is 3 or 4 men, with as high as 10 to 12 on extra long faces. Average output, in hand loading, is 1 to 3 cuts in the usual rooms. With self-loading equipment, production is increased to 2 to 4 cuts per shift—sometimes more.

Attaining production rates of this magnitude requires a careful study of crew size and operating cycle. Unless places are extra-wide or some special situation exists, the usual face crew, as noted, is 3 to 4 men. More than that number under normal conditions seems to result in interference and lost time.

The cycle itself is the critical factor in high productivity. For high efficiency, the various elements in the cycle—cutting, drilling, shooting, etc.—must overlap, and must be tightly scheduled to prevent waste motion and time loss. The basic goal is as little interruption in the flow of coal as possible. The best way of attaining it is through time study and the establishment of a fairly rigid system of standard times, plus a fairly exact schedule of when to do what.

Machine Mining

THE BASIC machine-mining unit, meaning here the unit based on a mobile loading machine, is made up of the loader itself, a cutter, a drill and, in most instances, one or two shuttle cars. Additional equipment may include a roof-bolting unit, a rock-dusting machine and a mobile supply truck.

A high degree of flexibility characterizes this unit, and thus it has been applied in practically all types of mining, including semilongwall, in both thick and thin coal and in both flat and lightly pitching seams. Number of working places per unit ranges from a low of two up to 20 or more. The average is 6 to 10. Crews range from 3 to 5 up to 20 to 25 men, with the most common around 8 to 12. Production per unit runs from as low as 100 tons up to as high as 1,500 tons per shift, with 300 to 600 tons as the majority. Tons per faceman ranges from 20 to nearly 100 in a few instances, with 30 to 50 perhaps the most common.

Machine Projections

Because of the flexibility of the load-unit previously noted, mining plans range from completely closed panels with no pillar extraction to what might be termed the wide-open system with all openings—entries, rooms and crosscuts—projected on the same centers. This latter, if followed completely, results in dividing the coal into blocks of uniform size, permitting both flexibility in attack and, at the same time, a standardization of extraction methods conducive to both high unit productivity and high tons per man.

LOW-ANGLE PILLAR LINES — Where pillars are removed with machine units, the tendency is to reduce the angle of the pillar line from 45 deg sometimes down to zero or to a completely flat line. Two major advantages result. One is that the span supported on the projecting points or stumps is materially reduced in going from 45 to some smaller angle. On a flat line the span vanishes. And as the span is reduced, the weight of top in the angle requiring support is reduced accordingly. In one instance a change from 45 to 22½ deg, with a minor change in block centers, cut the weight to be supported to one-third of the total under the 45-deg plan previously employed.

Whether short lines or stepped lines are feasible is another question in projection. Each case must be studied individually but there are instances of successful operation with very short lines. Also, there are instances of steps of considerable magnitude in lines as a result of permitting entry recovery to lag behind to provide room for a tail track, as well as permitting one group of rooms operated by one mining unit to get considerably ahead of the next group. The conclusion therefore is that with most top there is considerable flexibility in establishing and operating pillar lines, though, other things being equal, a reasonably long straight line normally provides the maximum results with a minimum of trouble. And whatever the system, a cardinal rule is getting the coal out clean or making sure that any pillars or stumps that cannot be recovered are shot before they are left.

PLANNING WITH MODELS—To reach better answers to questions as what methods are best, at least one operating company uses table-top models. The elements in table-top modeling are blocks of the correct size to represent pillars; cardboard or other sheets to represent stoppings and brattice lines; wire or cord for cables, etc., plus miniatures to scale of the machines. When a problem, such as where to anchor shuttle-car cables, comes up, it can be solved by setting up a typical working section and experimenting to find the best spot. Cuts of coal can be added or subtracted by using small blocks and an entire pillar-recovery cycle can be run through as examples of other things that can be done.

The overall look afforded by the table-top model makes it easier to see all the elements of a problem and thus frequently points to the obvious solution immediately, saving time spent underground and on experiments that do not work out (*Coal Age*, August, 1957, p 74).

PREVENTING BUMPS—In brief and perhaps oversimplified terms, bumps are the result of a concentration of stress in the interior of a block or blocks of coal as a result of weight. As the weight builds up, the coal in the pillar is stressed more and more, until it suddenly fails in explosive or semiexplosive fashion.

Preventing weight buildup is a combination of a number of things as outlined in a more detailed discussion of

bump prevention in the section on "Roof Control." Careful study will permit evolving a mining plan which will eliminate or reduce load buildup of the type which results in bumps.

In addition to mine layout, pillar design and pillaring system, bumps may be avoided by drilling or augering suspected pillars. In this process, the weight is unloaded gradually, or the bump is triggered while the weight concentration is small and before actual mining of the pillar starts. For a fuller description of the pioneer drilling and augering plan for bump control, see *Coal Age*, January, 1955, p 68.

Machine Plans

A key factor in efficient machine loading is coal and transportation at all times. An adequate coal supply requires, among other things, an adequate number of places in which to work. The basic rule is that as soon as the machine is finished in one place coal should be ready in the next for loading. Acceptance of this rule means that with conventional room haulage—usually the shuttle car—the minimum number of places usually is four, exclusive of crosscuts. In the past, however, some operators have approached the question from the standpoint of high tons per man from a small crew in two to three places. If tons per man are high enough, they compensate for the fact that fewer tons are secured per dollar of investment in machines. New equipment, on the other hand, removes this objection to a small number of working places. The bridge conveyor is an example, but even with it there should be enough places so that the loader never has to wait for coal.

SHUTTLE - CAR HAULAGE — Though there are many variations, the section layouts for shuttle-car haulage tend to be one or the other of two types:

1. The panel plan with rooms turned both ways and driven in groups of 5 to 7 or more. One reason for the use of this plan is the fact that pillars are not recovered. However, with modifications, pillaring can be done with this plan also.

2. The conventional block or room-and-pillar plan devised for pillar mining, either with short lines for each room section or longer lines advancing continuously from section to section. To facilitate the latter, some block plans, as noted in the Planbook elsewhere in this section, are set up with all openings on the same centers so that pillar lines can be established and advanced without having to shift gears when an entry is crossed.

In developing for both plans, the usual practice is to drive a minimum of 4 or 5 headings to make entry work as near like room work as feasible and thus as efficient as possible. Heading stations are established every 200 to 300 ft, at which distances the shuttle-car haul is kept under the generally accepted maximum of 500 to 550 ft. If track is used, it may be looped completely, or may be turned into a room or back down the next heading to establish a tail track for transfer from shuttle car to rail car.

With track setups, all shuttle cars normally must dump at the same point. Consequently one must occasionally wait on the other. Where panel belts are used instead of track, however, some operators restrict one shuttle car to dumping at the end and require the other to use a crosscut farther down to prevent interference and loss of time in waiting to use the same dumping point.

ANGLE CROSSCUTTING — Crosscuts may be angled each way from the center heading to facilitate higher-speed shuttle-car operation. This is especially true in operations based on mining individual panels, and particularly where pillars are left. In some plans, the angle crosscuts continue to become rooms, with angling continued in making room crosscuts. In a group of five or more rooms for example, the center usually becomes the key room, often leading directly to the car or belt-loading station. See accompanying Planbook for examples.

TOP BENCHING — Extra-thick coal offers some special problems in machine mining. At one mine, as an example, though the mining system went through a number of changes, all openings invariably were driven along the bottom. Top and rib deterioration and the onset of weight always outpaced the rate of extraction, thereby making it difficult to achieve the desired recovery. The cure was found in driving the openings in the top of the seam and bolting the roof, which permitted fast, economical removal of the lower portion of the pillars by loader or scraper (*Coal Age*, November, 1954, p 92).

TRACK HAULAGE — In loading directly into mine cars, maximum efficiency involves these steps:

1. As big a mine car as possible to reduce the number of changes per cut.

2. A one-way distance back to the closest changing point of not over 150 ft.

Prefabricated track provides a reliable means of attaining the second objective, as well as the further goal of track that can be installed, taken up and moved quickly and with a minimum of labor. Prefabricated track also forces adherence to the mining plan, which is helpful over both the short and long pulls.

CONVEYOR HAULAGE — Continuous availability is the major advantage of the conveyor as a haulage unit, but keeping the loader boom over the conveyor was a major difficulty in early installations. One solution was the bridge conveyor, followed by the extensible belt to reduce the stoppages for extension.

Bridge-conveyor plans normally are based on two or three places per unit. Basic equipment in the unit is two or three room conveyors, two or three bridge conveyors, a cutter and drill in each place, and a crawler-mounted loader, plus mother or cross conveyor, elevator, car-spotting hoist, roof-bolter, rock-duster and so on. The loader moves from place to place, and a mounted cutter may be substituted for the individual shortwalls, alternating with the loader. In general a good top or one which lends itself to bolting facilitates the use of bridge conveyors by making it easy to establish the necessary travelways.

Operation is much the same whether rooms or entries are being driven. An entry driving setup is shown in the "Opening and Development" section of this issue. Average performance in 34-in coal is 20 to 25 tons per faceman. One element in this performance is a tight well-balanced cycle.

A panel setup for bridge conveyors is shown in the Planbook in this section. Coal thickness is 26 to 36 in. The mining plan (*Coal Age*, April, 1957, p 60) is full retreat with pairs of rooms turned right and left off the panel entry. Panel haulage is by belt. Average output is 21 to 22 tons per faceman. A pair of rooms is completed in about five days. The conveyor lines are left in place and the mobile drive sections are trammed to the new sites with enough pans and the tail section to start the new rooms. Equipment moves take about 5 hr and are made on the third shift by six men from the regular crew.

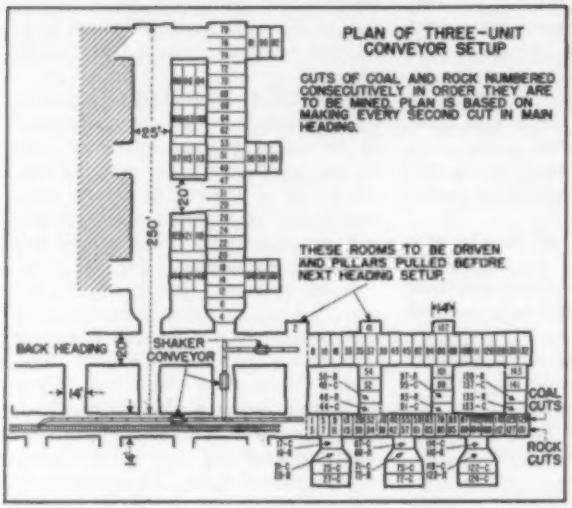
Pillaring Plans

Loading machines can be used in practically any system of mining individual room pillars, including slabbing and splitting. The two most-used plans, however, are open-ending and pocket-and-stump. Examples of these and other plans are shown in the "Continuous Mining" section of this Deep Mining Guidebook.

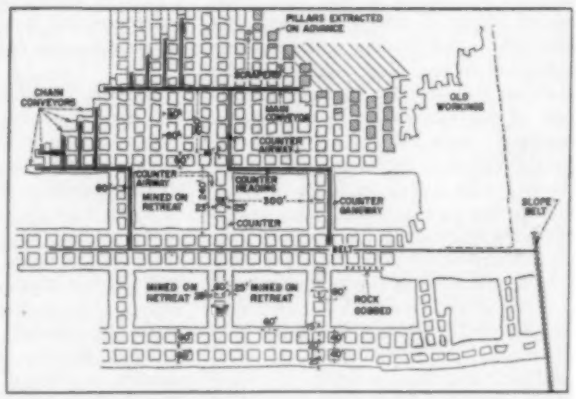
A variation of open-ending is pocket-and-fender, under which the stump is

Mechanical-Mining Planbook

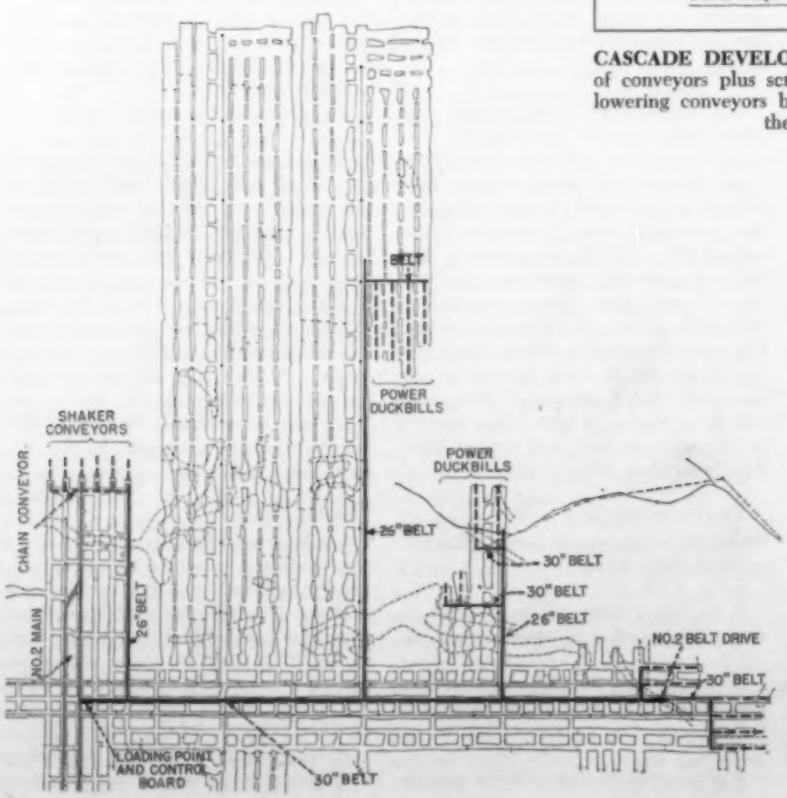
Conveyor Plans


PLAN OF THREE-UNIT CONVEYOR SETUP
CUTS OF COAL AND ROCK NUMBERED CONSECUTIVELY IN ORDER THEY ARE TO BE MINED. PLAN IS BASED ON MAKING EVERY SECOND CUT IN MAIN HEADING.
THESE ROOMS TO BE DRIVEN AND PILLARS PULLED BEFORE NEXT HEADING SETUP.
25'
20'
250'
140'
BACK HEADING
20'
14'
SHAKER CONVEYOR
COAL CUTS
ROCK CUTS

HEADING ADVANCE alternates with room work in this conveyor plan based on mining on one side on the advance and the other on the retreat. Rock is loaded every second cut in haulage headings, where necks are made extra deep.

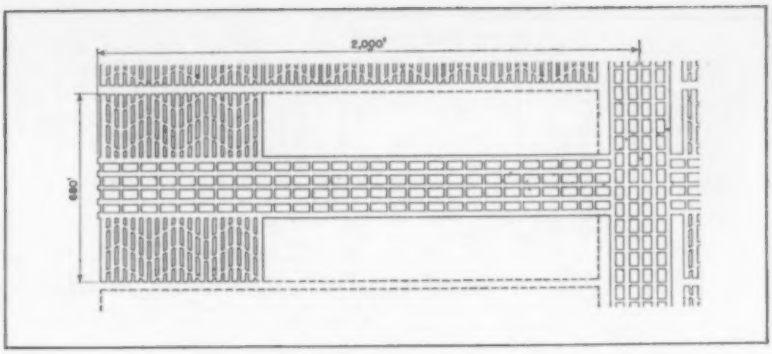


CASCADE DEVELOPMENT up the pitch with two groups of conveyors plus scrapers for recovering pillars. Chutes and lowering conveyors bring the coal down to the main belt in the crosspitch gangway.

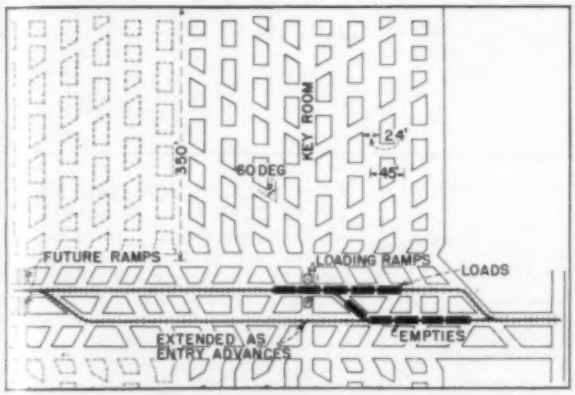


"CONTINUOUS-ROOM" PLAN for conveyor mining permits moving room units straight ahead a minimum distance by using mother and cross belts.

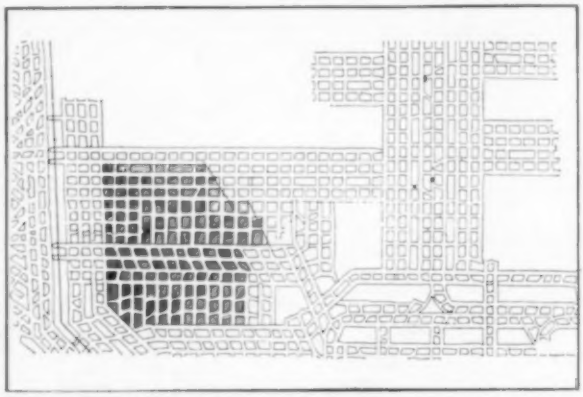
Machine Plans



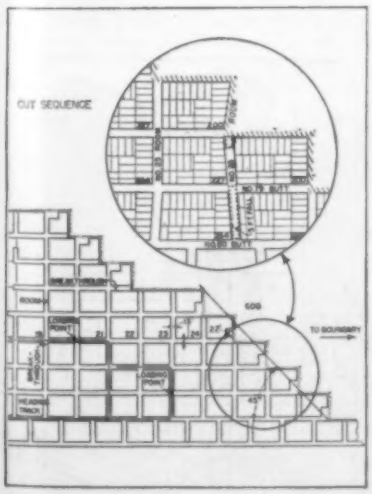
KEY-ROOM PLAN with shuttle-car haulage in thin coal. The center heading of the panel entry is brushed for track and mine cars. Rooms are worked in groups of five to seven, and the crosscuts are angled from the key room for easy shuttle-car travel.



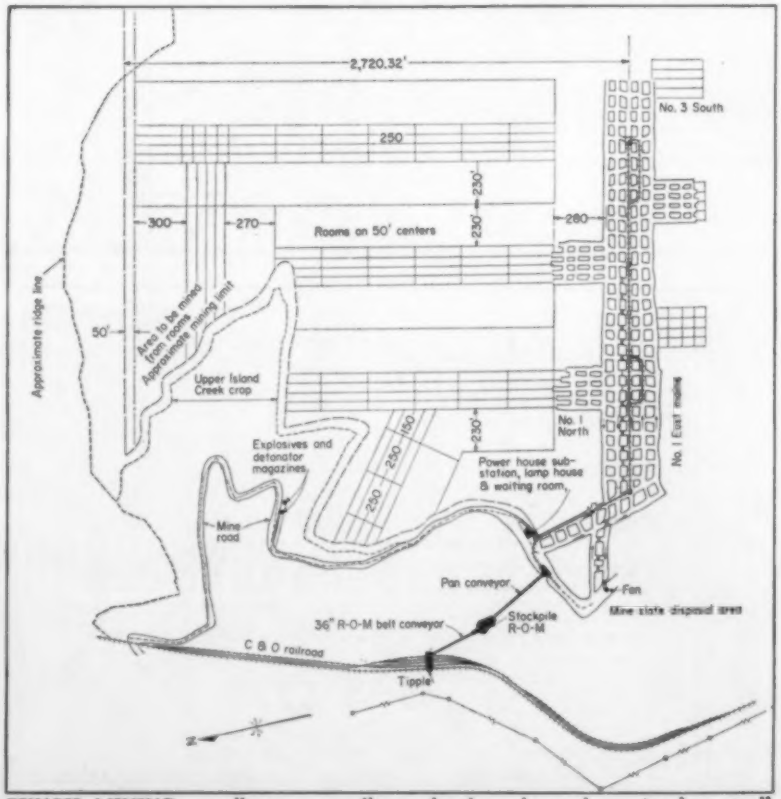
SHUTTLE-CAR PLAN showing double-tracking for mine-car loading, key rooms to loading ramps and angle crosscuts.



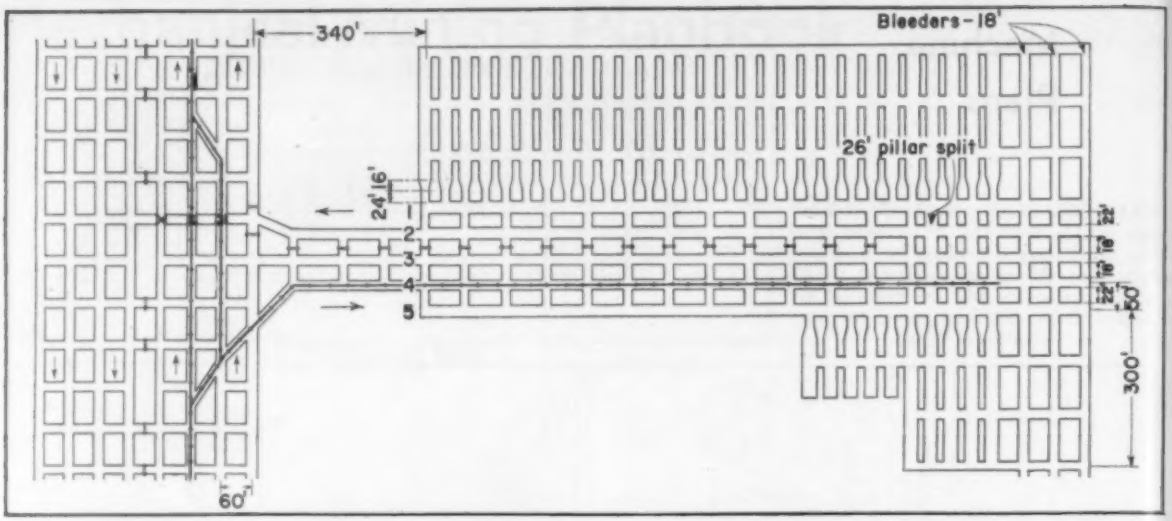
BLEEDER OPENINGS in this retreat plan for mobile loading machines are formed by leaving pillars along panel entry.

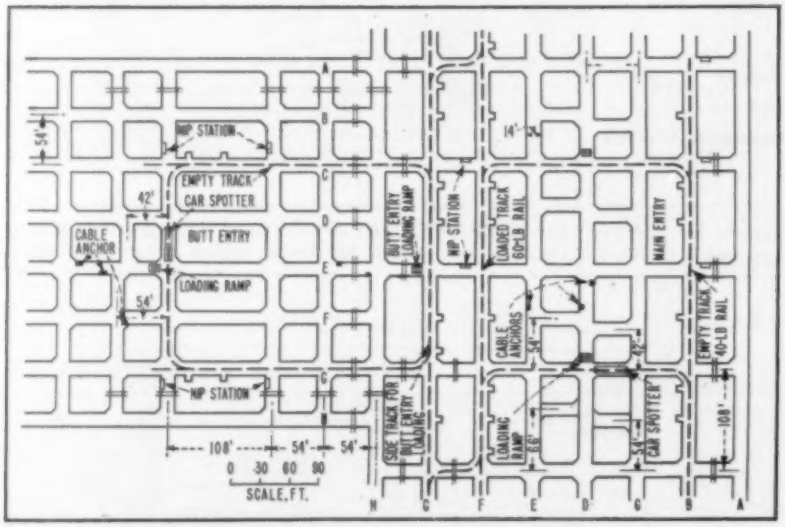


LOOP CIRCUITS simplify rail haulage and keep cars right-end-to in this block plan for shuttle cars. Pillars are open-ended in numbered sequence to provide close control of breakline. New places are developed only as necessary.



PUNCH MINING, usually on a smaller scale than shown here, involves small compact areas, usually with belts to the outside but with track on occasion. Advance on one side of panels and retreat on the other feature this setup for 3,000,000 tons.

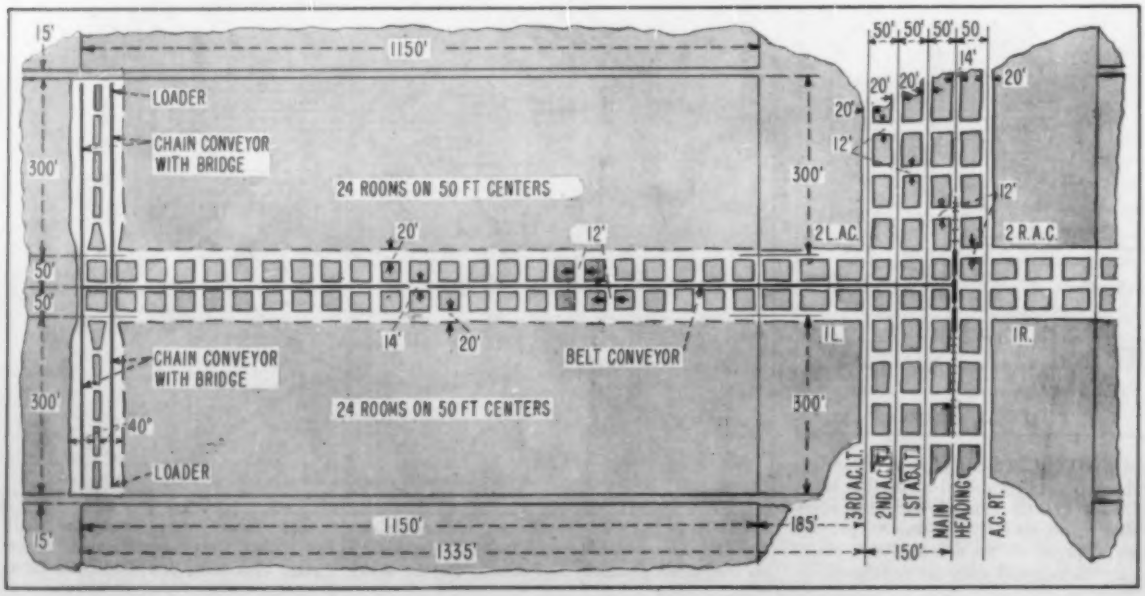




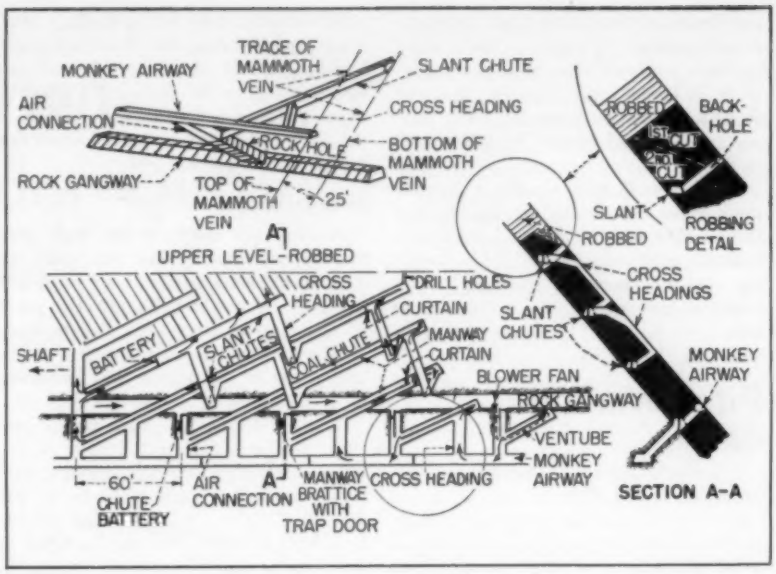
COMBINATION ADVANCE AND RETREAT PLAN keeps all work on fresh air. Places are normally driven in groups of five and pillars are left. Enlarged pillars at the top of the panel protect bleeder openings.

ROOM WORK is eliminated in this plan to permit straightaway advance with eight headings and subsequent mining of entry pillars.

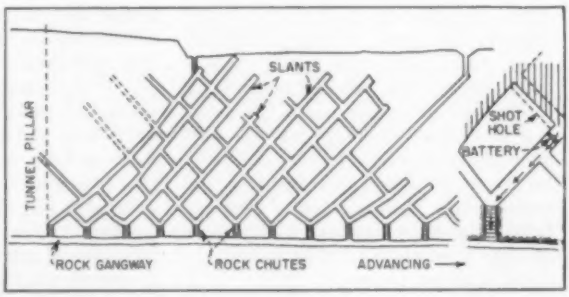
THIN-COAL PLAN is based on using bridge conveyors behind loaders in pairs of places on each side of panel entry.

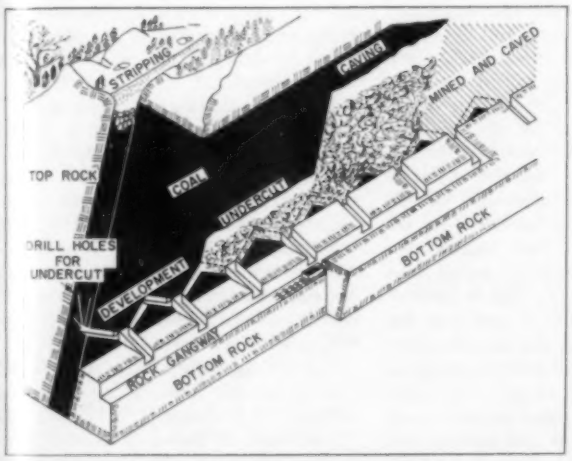


Pitch Plans

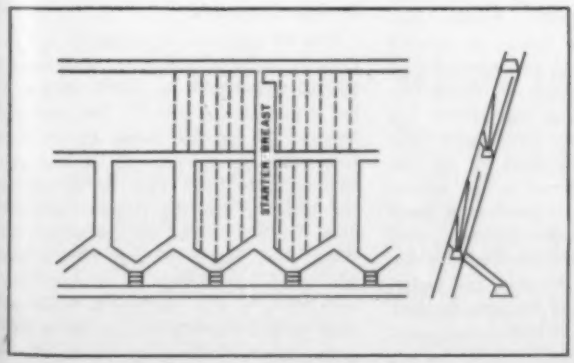


SLANT-CHUTE SYSTEMS (above and below) are examples of plans devised to reduce manual labor and raise efficiency in steep-pitch mining. In line with general practice today, gangways are driven in rock under coal.

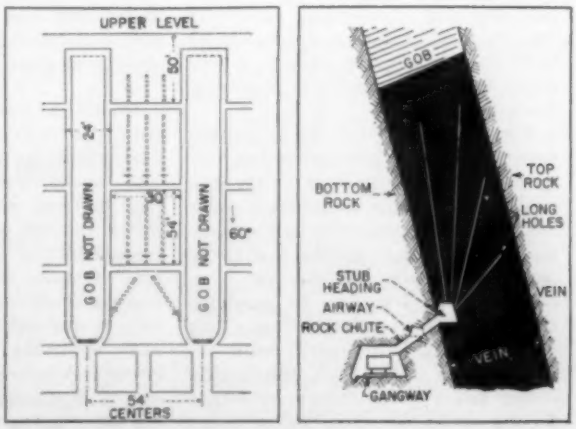




ORIGINAL INDUCED-CAVING CONCEPT for mining steep anthracite veins involving undercutting after development to start the caving.



LONGHOLE DEVELOPMENT PLANS include this version employing sub-breasts at intervals plus counters for removal of the coal in two lifts.



TWO LONGHOLE PLANS show (left) development along usual lines except that pillar size is increased to permit drilling and shooting, and (right) operating in nearly vertical vein with only drill headings in the coal.

cut down to a shell only 2 to 3 ft thick. A subvariation is gripping the cutting machine out each time to make a saw-toothed fender and increase recovery slightly. Timbering plans for pillar mining are discussed in the "Roof Support" section.

In open-ending, it usually is best to arrange the direction of advance so that the machine operator is on the side away from the coal and protected from sloughing and rib bursts, particularly when heavy weight is the rule and the coal is soft.

Pitch Mining

Light Pitch

Practically any type of equipment may be used at the face of places driven either up or down light pitches (normally 5 to 18 deg). Usually, however, some form of conveyor is necessary for transportation. With this limitation, all the ordinary panel plans, with or without pillaring, and practically all the conventional face equipment may, as noted, be employed. Usually, particularly as the pitch increases, the practice is to put headings up, down or both—usually up—and rooms across the pitch. Among other things, this permits the use of shuttle cars on pitches up to 10 to 12 deg or perhaps slightly more, the cars discharging to either a lowering or hoisting conveyor relaying the coal to the main-haulage system. Angle crosscuts between places permit easier movement of units from place to place in conventional machine loading.

Moderate Pitch

Galvanized iron kept wet provides perhaps the flattest gradient on which coal will flow of its own accord. The minimum is around 20 deg. At about 25 deg, coal will begin to flow on ordinary iron and, at something around 35 deg, on wood. Below approximately 20 to 22 deg, therefore, it normally is necessary to install conveyors to move coal down the pitch.

Where pitches of this degree prevail, customary practice is to sink belt or rope slopes, turn gangways right or left on a grade rising slightly to facilitate water flow, and then work rooms up the pitch, using hand labor to get the coal to the conveyor or chute. Modifications, however, include a few plans for crosspitch room work. One involves driving a pair of rooms up a 40-deg pitch and installing in one a timber track with hoist, a ladder and a chute. Rooms are turned 90 deg across the pitch, and a shaker is installed along the lower rib of each one. Cutting machines may be used at less than the maximum inclinations, and the machine rope may be used to pull a side-loading pan on a shaking conveyor uphill along the face to speed leveling. Pillars may be removed by open-ending, with the coal running down to the pan line. In some instances the open end may be angled toward the mouth of the place.

Heavy Pitch

Attempts to eliminate the high percentage of hand labor necessary in steeply pitching seams have included plans which would cut down the pitch of openings in which men had to work to that on which coal would run on either iron or the natural rock, meaning to a minimum of 35 to 45 deg. The "lattice," "diamond," "slant-chute" and other similar plans differ largely in details—for example, 30-deg openings with sheet iron and without batteries in one "diamond" plan, compared to 45-deg openings, no sheet iron and batteries at intervals in one "slant-chute" system. In both, the openings are first developed to the old gangway above and the pillars are recovered on the retreat back down.

Usually, one-third to half of the pillar is drilled with holes up to 45 to 50 ft, loaded with explosive laced with detonating fuse to insure complete detonation, and shot. The coal then flows to cars in the gangway, controlled as necessary by checks or batteries. In the slant-chute system a new battery normally is built immediately below each time a new section of pillar is shot.

Because life usually is long and disturbance in the vein can be substantial after mining gets well started, the trend is toward gangways in the rock under the vein, with rock chutes up to the coal. This leaves a strip of coal between the rock gangway level and the top of the rock holes. This strip may be recovered from the next gangway below, or short, level rock-holes can be driven to the vein, which then is opened up by chutes as necessary and then drilled and shot into short conveyors leading back to the rock gangway.

INDUCED CAVING — Another proposal for reducing labor in mining heavily pitching veins is "induced caving." Similar in principle to "block caving" in metal mining, the system has shown promise in its initial trial. The original idea, as developed by the Bureau of Mines, is shown in the accompanying illustration. It involves a gangway in the rock under the vein, rock holes up to the coal, slant chutes between rock holes in the vein, and undercutting of a section of the vein by drilling and shooting to induce caving.

Longholing

LONGHOLING — a fairly recent development—materially reduces the labor required in the preliminaries to production. Variations in longholing methods largely reflect how much preliminary development work is done. As an example, in moderate pitches, the conventional chambers and crosscuts may still be driven, the principal change being an increase in the size of the pillar left. The pillars then are drilled and shot instead of being mined in the ordinary way. Holes therefore are seldom more than 50 ft long. An example of plans where the emphasis is more on drilling of pillars formed along conventional lines is shown in the accompanying illustration.

Longholing with minimum development at one operation, is based on gangways and airways in the rock beneath the vein, with rock-holes to the vein at intervals fitted with batteries to control coal drawoff. Holes drilled back from the next rockhole and cased with pipe insure positive ventilation behind the battery both before and after shooting. Holes also are drilled to the next level above to drain off any water that may have accumulated.

Longhole drilling is done from a heading in the coal. To start a section, two places are driven up to the old workings and the chain pillars are removed to provide expansion room for the coal to be shot. Then the coal between two rock holes is shot by three groups of three holes each, one parallel to the bottom, one angling up through the vein and one directly toward the top rock. Firing is on off-shifts or idle days.

Longholing with a little more development in the form of sub-breasts at intervals and counters for drilling the upper block is shown in another illustration. For starting, one breast is developed up to the upper gangway. After the upper block is drilled the lower is removed in similar fashion.

The capital investment required for longhole drilling is relatively small and productivity at the face is increased 50% or more.

Boring Crosscuts

One of the more aggravating and expensive items in gangway development in coal in moderate to heavy pitch mining is crosscutting between gangway and airway. The big drill is one answer. Size may range from 24 to 42 in, and one, two or three holes may be drilled up the pitch to get the required crosscut area. In contrast to an earlier version (*Coal Age*, May, 1951, p 100) a new and much-lighter type (*Coal Age*, August, 1953, p 58) employs a hoist and rope to pull the big bit through a pilot hole. Another advantage of the bored crosscut is that a simple disk rather than an expensive custom-made stopping can be used to close it.

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Face Preparation For High Loader Output

Prime Objectives

An ample supply of well-prepared coal for loading at all times.

Conduct of face preparation itself at minimum cost.

Key Approaches

Careful study of bits, bar length and cutting pattern for maximum effectiveness.

Selection of drill types, bits, augers and hole patterns for most-efficient breaking.

Choice of shooting or breaking mediums providing the desired results in size consist and loadability.

Bits

CARBIDE-INSERT bits for either cutting or drilling normally are well worth their cost. A wide variety of designs are available and thus it is easy to match bits to coal and mining characteristics—and to change when characteristics change. Under some conditions, however, plain quenched bits may be quite satisfactory, with alloy and tipped types filling the gap between carbon and carbide.

PREVENTING LOSS—It is highly desirable to keep all possible metal out of coal, which is one reason for care in preventing bit loss or careless discard. Another is bit cost, particularly the carbide type. The rule, therefore, should be an old bit or a thorough accounting before a new bit is issued. Establishment of fixed quantities in the hands of each operator or crew, supplemented by regular inventory, helps keep down losses.

Protection against damage or loss is enhanced by such steps as locked cabinets, and special bit boxes and holders for carrying and storing bits. See accompanying illustration for examples.

BIT MAINTENANCE—Though there are times in coal mining when the bits just have to take it, one secret of long life and low cost is care in use, including care to remove bits for reconditioning before excessive dullness results in damage, in addition to slowing down the cutting and drilling rate.

Grinding methods can materially affect the cutting qualities of carbide-insert bits, and also the total number of regrinds possible, in turn affecting service life. Manufacturers' recommendations should be the guide. For a step-by-step illustrated description of grinding and recondition both cutter and drill bits, see *Coal Age*, July, 1957, p 71.

Cutting

HIGH CAPACITY and greater ease in moving are the major reasons for the increasing use of rubber-mounted cutters, now available for coal as low as 36 in or less. Below that, the shortwall is about the only answer, as well as in coal pitching more than about 10 to 12 deg.

Hydraulic and other modern controls make the modern shortwall a more-versatile and higher-capacity unit. Bug-dusters can materially reduce labor and normally make it unnecessary to clean the kerf. Otherwise, kerfs should be cleared of cuttings to promote safety in shooting, reduce powder consumption, prevent "hung" cut and generally improve loadability. However, certain newly-developed cutting systems, notably the "three-pass" summarized later in this section, reduce or eliminate the need for bugdusting facilities or labor.

Long bars are a distinct advantage in machine loading, since the more tons per fall the fewer the time-wasting moves the loader has to make. Cutting with a long bar, however, requires greater operator skill and increases the risk of striking undulations in the bottom and top, as well as the risks of fouling and binding. If they replace shorter bars on existing machine, care should be taken to make sure that the motor can carry the extra load, either as is or with improved insulation.

Cut Positioning

Simplicity, ease and custom are behind the preponderance of undercutting, which has the further slight advantage that the fall helps to break up the coal. However, it normally necessitates shooting against the top and thus, where this results in serious deterioration, has led to top cutting. Cutting at other horizons may be done to get into softer zones, but usually is adopted to remove bone or rash. Where the latter is the goal, two or three cuts may be taken—or one regular cut may provide enough loosening and relief so that most of the remaining material can be raked out.

BENCH MINING—Cutting under a middle parting in thicker coal may be done as one step in bench mining, the lower bench being shot up and loaded, followed by dropping and disposing of the parting, and shooting and loading of the top bench. Very infrequently, cutting may be done in rash or soft clay under the seam, or in soft material above, either to keep the kerf out of the coal or to eliminate hazardous or troublesome top material. However, such selective mining is on the decrease and the trend today is toward full-seam extraction, including, in some instances, top stone or drawslate. This system relies on mechanical cleaning on the surface for removal of the impurities, since it normally results in a lower overall cost.

Special goals in cutting include raising the undercut where the bottom is soft to provide a good coal pavement for the operation of shuttle cars and other equipment.

Multiple-Pass Cutting

Under some circumstances, making more rather than fewer cuts may be an advantage. A three-pass system developed by one company is shown in an accompanying illustration. Benefits in-

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Equipment . . . Cut positioning . . . Multiple-pass cutting . . . Shearing

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Mounted units . . . Hand-held units . . . Augers

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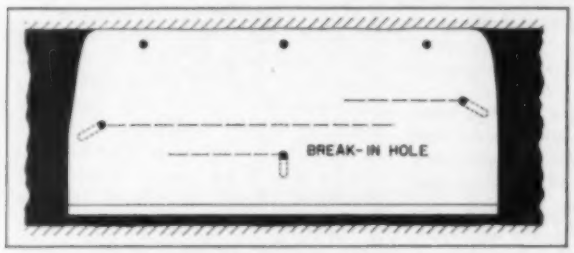
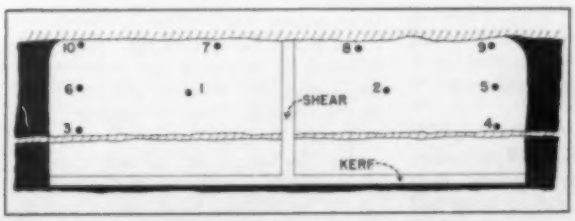
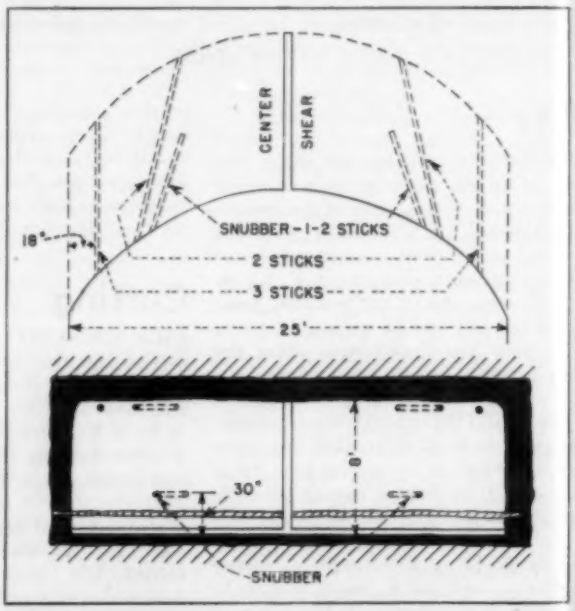
MULTIPLE-HOLE AIR BREAKING involves rubber-tired truck for transporting tubes. The truck also is equipped with a sequencing valve for discharging tubes automatically after tripping by the operator.



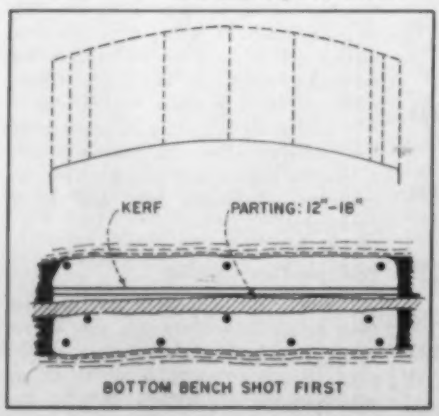
BREAK-IN-HOLE provides additional free face for relieving succeeding holes. In this plan, rib holes are stepped up to break lower part of face in section.

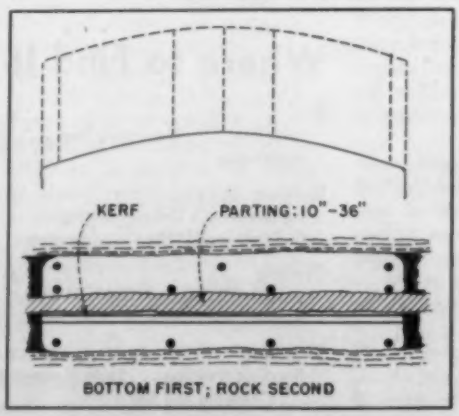


EQUALIZED BURDEN is the goal in this drilling pattern in a center-sheared place, thus achieving good breakage of both coal and impurity band.

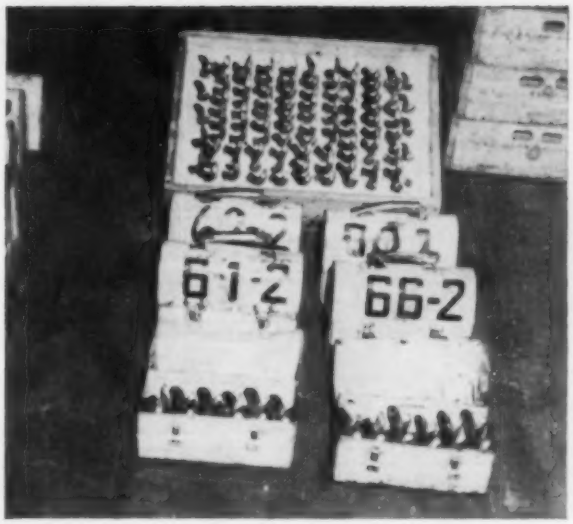


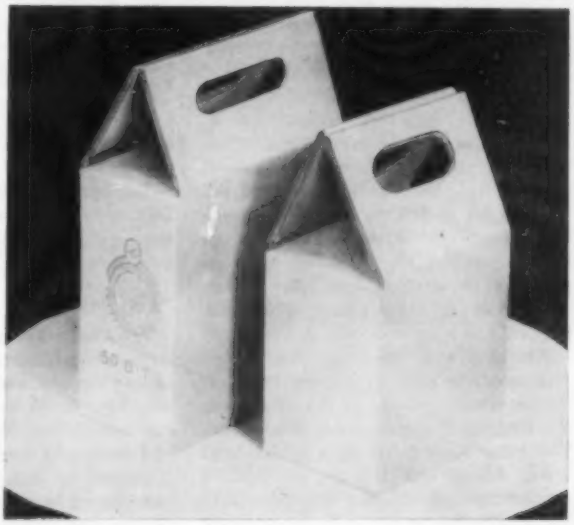
SHORT SNUBBERS break band and roll out front of fall in arc-cut center-sheared place. Shearing and snubbing reduce the number of holes required and also cut explosive requirements.





SHOOTING WITH HEAVY PARTINGS. Plan at left shows cutting above the parting, followed by shooting of the bottom bench first. Plan at right, for still-thicker parting, shows cutting underneath the rock and holes immediately above.





PROTECTION AGAINST DAMAGE OR LOSS is especially necessary with modern cutting and drilling bits. Above photo shows locked cabinet for preventing loss and mishandling. Cabinet has compartment for each section's supply. Upper right photo shows wooden bit holders in lunch boxes carrying section numbers for easy handling. At right are corrugated-filler boxes—one of the newer ideas for carrying and storing bits.

cinde a substantial increase in tons per cut, reduced loading time, lower power consumption and less wracking of the cutter. Obviously, cutter capacity should be great enough to permit the extra passes without falling behind the loader.

Shearing

The vertical cut, or shear, provides an additional free face, or faces, and is highly valued by many operators as a means of reducing explosive consumption, raising coarse-coal yield and increasing loadability, even though it does result in more bugdust. In permanent headings, some operators have sheared booth ribs to keep them free from shooting shock and thus postpone and reduce falls and sloughing.

Since shearing takes time and, as noted, increases the output of cuttings, shear cuts normally are limited to one—usually at the side in headings or other narrow openings, and between one-third over and the center in rooms.

Drilling

DEPENDING UPON CONDITIONS and personal preference, operators have a wide choice in drilling equipment, including not only pneumatic equipment but also hand-held, postmounted and mobile units. The latter may be designed with one or two arms, with the hydraulic auger drive now coming to the front for greater capacity and flexibility. Hydraulic drill positioning frequently can release one man from the crew for other productive work.

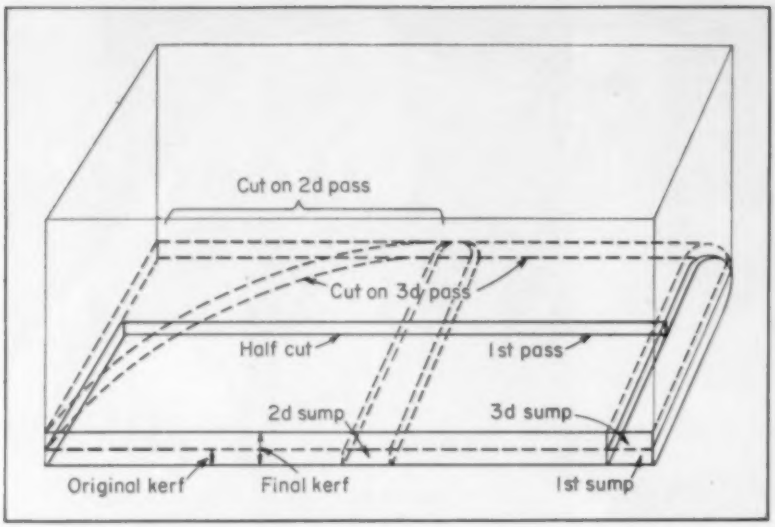
Hand-held units driven either by flexible shafts or hydraulic motors are a relatively recent addition to the types of drilling machines available and in some instances have successfully challenged even large mounted units. Light weight, high speed and operation from the cutting machine through either a mechanical or hydraulic takeoff are among the secrets of the machines' success. Where the cutters do not have a hydraulic system, certain operators have found the drill benefits sufficiently large to warrant installation of a special portable hydraulic power unit.

AUGERS—The "conveyor" auger or approximations thereof now has taken over to a considerable extent from the old twisted auger in coal drilling. Advantages include greater rigidity, with consequently less whip, and more resistance to bending. These features are especially valuable with hand-held flexible-shaft or hydraulic drills, where whipping or a bent auger is especially noticeable. Better hole cleaning also is an advantage, particularly where large holes are necessary.

Better cleaning of wet down-pitching holes may be attained by changes in scroll-pitch—usually an increase.

Shooting

A WIDE RANGE of explosives and several breaking devices are available for the operator's choice in coal breaking. The breaking devices include carbon-dioxide, air and chemicals, all basically relying on building up pressure in a tube against a disk which ruptures at a



THREE-PASS CUTTING PLAN involves, first, sumping in at right, pulling out halfway and then cutting to left rib; second, sumping in center and cutting to left; and, third, sumping at right immediately over old kerf with bar tilted down toward back, cutting to center and then tailing out at left side. Third cut also cleans the kerf.

SAFETY ACCESSORIES include galvanometer to test circuits in millisecond delay shooting—a growing practice for promoting both safety and efficiency.

certain limit to release the gas or air and break the coal. Air is the most-used non-explosive breaking medium, and the practice for some time has been to supply it from central stations on the surface, sometimes supplemented by large portable or semiportable units underground at strategic points throughout the mine.

Breaking with air recently has been facilitated by the development of sequence-discharge equipment permitting the loading of several holes at one time. The tubes are carried on a rubber-tired truck, which also is equipped with a sequencing valve. After placing up to six or so tubes in the holes the operator retires and trips the sequencing valve, which discharges the tubes at intervals of 12 to 15 sec. Normally, all holes in a single row are shot in one group, starting at the bottom. At one property use of the multiple-hole unit permits drilling and breaking up to 450 3-in holes per shift.

As a rule, carbon-dioxide, air and chemical breaking require a greater number of holes because the maximum force is less, though some operators get by with no increase and many with only a small rise in number. Any increase or other extra expense normally is more than offset by an increase in coarse-coal yield, or by other benefits, including ability to break coal on shift where all other shooting or breaking is forbidden by law or regulation.

To get the effect of a slower action with powder, some form of "cushion shooting" may be employed if other conditions are favorable. The air space around the charge may be secured by increasing the size of the hole or by placing the charge or stemming to leave an air space ahead or behind. Caution must be exercised to see that cartridges are not separated, thus setting up conditions favoring possible misfires.

Hole Placement

Shooting patterns are almost as numerous as coal mines. Normally, the best pattern for any mine can be determined only by careful study and considerable experimentation. One basic principle is that each hole should "relieve" the next. A second is that the burden on each hole should be adjusted to the maximum charge that can be loaded, though this maximum does not have to be the legal maximum. Consequently a common pattern is a row of holes in the top in thin coal, or in the top and middle in thicker coal, with the center hole shot first in the bottom row in two-row faces, and in the top row in one-row faces.

Modifications are numerous. One, as an example, is a row of holes immediately over a slate parting low in the seam to smash it and relieve the regular holes. Another is the snub shot, which may be a full-length hole in or close to the center to knock down the lower part of the cut and open up the face for the subsequent holes. As a variation, the snub hole may be drilled only part way in to break down and roll out the front of the cut. Bottom and snubbing holes may be angled down to get better breakage at the back and more force to kick the coal to the front.

Concentration may be sought for or avoided. As an example, the benefits of drilling a smaller hole may be more than offset by the stringing out resulting from use of smaller cartridges, thus preventing sufficient concentration of force to break the coal properly and economically. On the other hand, concentrating the force at the back of a deep cut in thin coal may result in the charge breaking down to the kerf in the back and leaving the front standing. One remedy is a slower-acting medium in more of the hole.

Charging and Firing

Stemming always is used with conventional explosives, but normally not with steel-tube blasting devices. However, instead of stemming, safety regulations in some regions require setting safety barriers or deflectors against each hole or the entire face to eliminate flying tubes. In lieu of conventional stemming, blasting plugs may be employed with explosives to save time. Conventional stemming includes the plastic clay dummy made by extrusion and available from extrusion specialists operating in many areas.

Single-shot firing with electric detonators still is the predominant system in the coal mines. However, it has definite disadvantages, one of which is the fact that the shotfirer is constantly exposed to the hazards of loose roof and must work in considerable smoke and dust in connecting to each charge after the first. As a result, there has been a substantial increase in millisecond delay ignition of shots in sequence. There is equal safety in relation to gas and dust, less chance of overbreaking exposing the following charges, less shock to the roof, and much less exposure hazard for the shotfirer.

The Deep-Mining Guidebook . . .

Effective Roof Control At Minimum Cost

Prime Considerations

Protection of men and equipment from falls, crushes, bumps and other top, face and rib failures.

Keeping working places, including entries, open for the desired length of time, whether hours or years.

Achieving the collateral goals of no interruption of, or handicap to, haulage, travel, ventilation or other openings as a result of roof action—at a minimum cost for support.

Logical Action

Know what is involved in roof action.

Study roof at the mine carefully, especially the possible variations, as means of selecting the proper support system or systems.

Adopt standards for minimum support and insist on its being increased if there is any indication that it is necessary.

Mechanize the timbering operation to the maximum extent possible for economy.

Salvage supports to the degree consonant with safety to cut down the cost of support materials.

ROOF SUPPORT is almost always required in coal mining either to protect main openings for the life of the mine or production places from falls that would endanger life and equipment and hamper production. This results from the fact that as openings are made in coal removal, the equilibrium of stresses is upset. The unsupported weight of the top results in a tendency to sag. This sagging continues until failure occurs unless (a) support is provided to prevent such failure or (b) the strength of the rock is such that it can support itself after the sag reaches a certain point.

Support varies with the objective, and also with the character of the material over the coal. For example, temporary protection against drawslate will require one type of support, while another type will be more suitable where both the drawslate and all the overlying material must be held. Still others will be better suited to permanent openings in bad top or caved ground. Weathering as a result of changes in temperature and moisture content of the ventilating air may warrant sealing the top, which is "support" in another guise.

In no instance, however, is it contemplated that the support provided by the original coal bed be replaced by support that will keep the roof in its original place and state after all the coal to be mined is removed. Even "permanent" support means only support until mining is completed. Between the time the coal is first opened up and the final pillars are removed, therefore, a number of roof conditions and roof actions may be encountered—some at every mine and all at some mines.

Timbering

TYPES OF SUPPORT in the "timber" classification range all the way from roof jacks at the face to steel, concrete and brick linings in permanent openings. Between these limits, timber includes posts, legs and bars of wood, steel and aluminum; yielding arches and rings of reinforced concrete and steel; concrete, brick and masonry columns, piers and abutments; such supplementary items as wedges, capboards, headers and lagging; and coal itself. Other forms of support, in addition to timbering, are bolting, and coating, sealing and bonding discussed later in this section.

Permanent Timbering

The goal in permanent timbering should be "permanence," meaning that life of the support, within economic limits, should match the expected life of the opening. This is not an absolute rule, however. In ground where movement can be expected for some time until the measures stabilize (longwalling, or driving gangways through previously worked ground, for example), it may be desirable to make the initial timbering job a temporary one, replacing it with final permanent timber when things have settled down.

As an example of "permanence" which is not permanent, consider the case of untreated wood with a life of around 3 yr in a haulage heading with a life of 10 yr. Since treated wood normally will last at least 10 yr, it could be considered "permanent," whereas with untreated wood the initial installation would have to be replaced at least once and probably twice, with each replacement normally more expensive than the original. The moral is that within limits it is better to spend more at the start for permanence, not only to eliminate replacement, and also production stoppages as a result of falls, but to keep routine maintenance as low as possible. When timber is installed so that it doesn't rot, fail under load, or permit sloughing and spalling, as examples, conditions are most favorable for keeping maintenance to the bare minimum.

Conversely, of course, timber or support life can be excessive—and thus excessively costly—in relation to life of opening. As an extreme example, it would be wasting money to line a 5-yr-life opening with reinforced concrete, though a sand-cement mixture an inch thick on wire might well be the thing for this particular application.

LINING—Support by complete lining is limited to rather special situations in mining. These include: soft sections of top near the outcrop in a permanent drift opening, or other soft or broken areas, as under stream valleys; and permanent long-lived openings on shaft or slope bottoms. Reinforced concrete is the old reliable in heavy-duty linings, and also provides complete sealing. Sealing with some support is provided by sprayed-on sand-cement mixtures, though support is only nominal when, say, the

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Coating and Sealing ..... p 244
Coatings and their application . . . Injection bonding

Field Reports

Roof Bonding With Resin—Test work by USBM indicates that epoxy resins with hardeners can be easily injected into the roof and have good possibilities for converting it into a high-strength beam. *Coal Age*, January, 1958, p 116.

Application of Visual Tension Indicators—One indicator installed approximately every eight bolts almost completely eliminated roof falls in bolted areas as a result of more-accurate tensioning and improved drilling. *Coal Age*, September, 1958, p 80.

Concurrent Bolting With Planks—With weak drawslate occurring with other weak roof members, 2x8-in planks installed with 6-ft-long bolts were found the best answer in ripper mining. Roof bars on hydraulic jacks ahead of the operating positions protect bolters. *Coal Age*, September, 1958, p 92.

The Facts About Draw—Rock character and the way it breaks up rule out the old "draw" theory. Surface action is the real cause of breaks back over the coal. *Coal Age*, September, 1958, p. 98.

coating is only ¼ to ½ in thick. When applied over wire and in thicknesses up to 1 or 2 in, they provide some holding power in addition to sealing. Steel liner plates also provide ceiling with a considerable degree of support, and are low in cost and easy to install, using a concrete footwall as a starting point.

GROUTING—Though not strictly lining or coating, grouting has been used to strengthen top in sections of permanent openings under, for example, stream beds where the overburden is thin and the top is rotten. Elimination of water seepage may be a secondary goal. Sometimes it is the major one, with strengthening of the top as a collateral benefit of the grouting operation.

PIERS AND ABUTMENTS—Supports of these types usually are found at pillar points where openings fork, and at other places where considerable resistance to roof movement is necessary. They may be built of concrete, with or without reinforcement, concrete or cinder blocks, brick or masonry.

YIELDING ARCHES AND RINGS—Where weight is substantial, the top is badly broken, and there is a possibility of movement of the gound in which the opening is made, yielding arches or rings may be installed. Some types employ concrete blocks put together on the keystone arch principle. Of the steel types, the latest is the full-round with joints that slip and thus permit diameter to decrease without deformation until equilibrium is re-established.

THREE-PIECE SETS—Probably the widest used of all forms of permanent timbering, the three-piece set—a crossbar supported on legs at each end—may range from a simple affair put together at the site up to a preframed and largely standardized set designed for heavy duty. Wood is the commonest material. As noted previously, it should be treated where life of opening is expected to exceed about 3 yr. The set also may be made of steel or may consist of wood legs and a steel bar where extra stiffness and resistance to bending are desired. If steel legs are used, they should be set on concrete piers or low footwalls for maximum stability, especially in longer-lived places.

Wood is easy to obtain and work, and the three-piece set is both flexible and adaptable. Also, it supplies the required degree of support except under exceptional conditions, in which case special concrete or timber arches are about the only answers. Legs, however, reduce clearance and can be knocked out to cause, in many instances, severe falls, aside from the fact that they themselves represent an expense.

Two-piece sets are an alternative to three-piece under certain conditions—for example in a water-level gangway in pitching coal where one end of the bar is hitched into coal or rock and the other is held on a leg.

HITCH TIMBERING—To eliminate the leg and its hazards, bars may be installed in hitches either cut or drilled in the rib. Hitch holes may be provided for each individual bar. As an alternative, holes may be drilled some distance apart to accommodate pins. Steel bars are then laid on these pins and the regular bars are placed on these stringers. Properly done, hitch timbering is permanent, especially if treated wood or steel bars are employed, and cost of installation (labor and materials) is much less than installation of a regular three-piece set. Routine maintenance and cleanup are cut to a minimum.

LAGGING—Spalling of top and sloughing of ribs are the reasons for the installation of lagging, which may be small natural round timber or sawed material. In long-lived openings lagging, like main timbers, should be treated. Lagging also provides some support, but its major function is holding loose roof material in place.

SINGLE POSTS—These have a wide use in permanent support, especially in openings where the spacing can be cut down, as in airways, manways and belt headings, or where the roof needs some support but a span of, say, car width can be tolerated. Short headers may be used to increase holding spread in tender top. As with bars and lagging, permanent posts, together with wedges and headers, should be treated.

COAL—Coal itself is widely used as a means of protecting and supporting top, though the support is chancy and not too great from the standpoint of resistance to weight. Sealing of the regular top is perhaps coal's major contribution.

Temporary Timbering

Temporary support naturally finds its widest application in the active working areas, including the working face, the room and the room entries. The major objectives are perhaps three:

1. **Protecting men.** The average dimensions of roof falls resulting in fatalities is given by the Bureau of Mines as: length, 13 ft; width, 11 ft; thickness, 2 ft. The majority of these falls (75%) occur in the face area inby the last permanent support, and 95%, says the bureau, are a result of human failure, meaning in turn primarily failure to install proper support.

2. **Keeping workings open.** The aim here is to preserve access to the face area from which production comes.

3. **Holding top during pillar removal.** Here, the support should have sufficient strength not only to hold the place open as long as necessary, but also to break the top at the desired point and thus help initiate the caving process.

STANDARD PLANS—The key factor in temporary support, particularly in the critical area within 25 ft of the face, is a plan for minimum support rigidly adhered to and supplemented with additional support where there is any doubt that the minimum is insufficient. The fact that nearly a third of the roof-fall fatalities occur where a timbering plan has been established is reason for emphasizing the need for supplementary support.

FACE-AREA SUPPORT—If coal is to be produced, both machines and men must work in the face area, which also means that timbering must be planned to permit reasonably efficient mining while

Roof and How It Acts

THE ROOF-SUPPORT PROBLEM in coal mining varies with, among other things, the type of top. Really good top is exceptional, while poor is becoming more common. The material of which the roof is made up is of course a major factor in its strength. Clays are the villain it is now believed, since investigation leads to the tentative conclusion that where they are present and are saturated with water the roof is likely to be weak. Mine roof rock usually is water-saturated.

1. **FALLS OF IMMEDIATE TOP**—These result, among other reasons, because the top material is inherently weak, such as, drawslate or clod; because of cracks and cleavage planes; because of the presence of kettlebottoms, slips and the like; because of weathering; and as a result of such mining operations as pillaring. Such falls constitute the majority of the "accidental" type, and are the ones causing most of the injuries and fatalities, most of the operating interruption, and most of the cleanup expense.

One question with thin, relatively weak roof layers over the coal is, "When to take down and when to leave?" Sometimes the material is so weak and crumbly that the question becomes academic, since there is no practicable way of keeping it up. Roof-bolting with channels, bars and short headers or cap-boards has made it possible at times to support top that otherwise could not be handled and which, when thick enough, rendered mining doubtful or impossible because of cost, hazard or both.

Depending on coal price, seam thickness and volume to be handled, a certain thickness of top material can be taken with the coal in room and pillar work. However, when this thickness reaches 6 in or more, the chances of economical production are considerably reduced if not completely eliminated. The rule, therefore, is to hold top material in working places, especially since support commonly is necessary for other purposes. There are exceptions, of course, to meet special conditions. In permanent or semipermanent openings, the answer is "Yes and no." One of the conditions, for example, which might lead to a decision to take top is a weak or crumbly drawslate over which is a good slate or sandstone. To save lagging of the slate, cleanup later on or both, the top would be taken to the hard material in installing support.

2. **RIB AND FACE FALLS**—An alternative form is sloughing which may be defined as minor face and rib falls, with spalling a minor form of sloughing. Rib and face falls also are of the type classed as accidental. Under certain conditions—thick, pitching coal, for example— such falls represent a real hazard. Sprags against the face and posts with plank stringers or lagging along the ribs are among the safeguards.

3. **SQUEEZING**—In its commonest form, squeezing is the slow increase in weight on pillars or solid coal eventually resulting in such things as crushing of the coal, heaving of the bottom and the driving of pillars into soft floor or top. The cause normally is leaving pillars or other support which, after considerable area is opened up, proves to be inadequate, permitting the top to settle gradually with transfer of the weight to active places and solid coal.

An alternative to squeezing is sudden collapse, which may also occur after a period of squeezing. Like squeezing, sudden collapse is rather infrequent, but it does occur, especially where thin room pillars customarily are left, or where a strong member in the top results in the creation of a large open area without a fall in pillaring. Preventives include ample pillar area and careful attention of getting initial breaks quickly.

4. **BURSTS OR BUMPS**—These are the sudden, explosion-like failures of coal as a result of internal stress caused by weight. In most instances, conditions conducive to bumping include heavy cover with strong members and especially a strong member close to the coal; a point at which weight and stress tend to concentrate, as the apex of two converging pillar lines, a barrier pillar sticking out into the gob, and so on; and a strong floor. As noted elsewhere in this "Deep-Mining Guidebook," drilling and augering can be used to trigger bumps or unload stress before it becomes too great. The basic line of defense, however, is adjustment of the mining plan to prevent stress buildup. Some suggestions are:

Get all the coal. Clean out timber also, since leaving props and cribs can help set up conditions conductive to bumps.

Mine pillars as fast as possible—at an even rate. The quicker pillars can be mined, the shorter the period of time for stress development.

Orient the pillar line with the natural fracture system of the roof to promote caving in the gob, thus preventing the formation of long roof spans. If long spans cannot be avoided, some means of support should be provided to prevent breaking. Cribs are an example.

Keep development out of abutment or stress areas next to pillar lines and gobs, and develop for new pillars away from rather than toward such areas.

Adjust mining to prevent the formation of points on pillar lines. Keep lines even—no projections into the gob area.

Keep pillars as large as possible to reduce the chance of failure under stress. Uniform size and shape keeps stress even and prevents concentration on certain large or odd-shaped pillars.

Mine individual pillars open-end where possible and keep lifts fairly narrow.

5. **INTENTIONAL CAVING**—Since caving relieves the remaining coal of weight—at least in substantial measure— and thus eases the job of mining and support where pillars are removed, much of the roof action in mining is intentionally induced. A common goal is a fall each time a lift is taken off a pillar, and this goal is fairly easily reached under conditions ordinarily encountered. Thus, support is provided to (a) break the top at the edge of the new lift and (b), with other support as necessary, to hold the top within the lift and keep it open.

Roof action in intentional caving commonly takes place in two to three stages. The first, or initial, break snaps the roof off at the breaker line. The cave commonly extends 25 to 50 ft up into the main roof. This is followed by a secondary cave, spanning several of the initial caves, and extending up to, say, 150 to 300 ft. If this is not sufficient to take the action to the surface, a third cave and general settlement normally occurs. Usually it is of sufficient magnitude to reach the surface unless the cover is exceptionally thick. Where subsidence is limited by packwalls or some other form of support, the initial strata may be cracked as a result of bending in the slow subsidence but falls of the type encountered in complete caving are relatively infrequent. Also, roof action, aside from a gradual and limited subsidence, seldom extends to the surface.

at the same time providing maximum protection against all the hazards of newly exposed top whose condition is largely unknown.

Among the specific hazards are slips, clay veins, kettlebottoms and the like, aside from general weakness, as in the case of certain drawslates, clods and the like. Also, unless caught, certain roof members will separate and sag, thus requiring more attention than if they had been secured immediately. Swelling or disintegration as a result of moisture are additional difficulties that may crop up in face support.

Safety Posts. The first line of defense in face support is the safety post or safety jack. The latter has the advantage of being easier to install, as well as to move to permit machines to pass. Interference is relatively little with hand-loaded conveyors but increases progressively as mining moves toward mobile machines.

Scaling. An elementary precaution in face work is scaling to remove loose material—usually before or concurrent with the installation of safety jacks. Under some circumstances it is possible to mechanize part or all of the scaling—for example, by mounting a scaling bar on the head of a loading machine and using the machine crawlers to force the bar into the loose material and peel it down (*Coal Age*, August, 1958, p 140).

Crossbars. The crossbar is one logical answer to keeping support close to the face while at the same time keeping down interference. Where the coal is low, cross-barring, especially if weight sags the bars, may result in too-little clearance for mobile equipment. This has resulted, in some mines with poorer top, in conveyors being chosen instead of loaders.

Roof bolts. Roof bolts also have the advantage, in most instances, of providing good support with maximum headroom. In many instances it is possible, by modifying the face cycle, to install them as the coal is loaded, starting for example, on the right rib as soon as enough coal is loaded to make room. In addition to independent bolting units, many continuous miners now are being equipped with dual bolters so that support may be installed as the machine mines the coal.

Face shields. First advocated in *Coal Age* in a discussion of "Timbering for Safety in Mechanical Mining," March, 1945, p 89, the face shield is perhaps the most-logical device for protecting men in the face zone. The original *Coal Age* idea was wire mesh on a frame supported on jacks. As now being developed by the Bureau of Mines, one modification is a frame with bars similar to fore poles on the top which could be moved up as the face advances.

Support installation. Face support plans are almost infinite in variations but the general routine is to extend posts, crossbars or bolts to the face immediately after loading to protect the cutters, drillers and others engaged in preparing the next fall. Roof jacks may be used to protect machine operators specifically and saddle jacks may be employed under bars to permit movement for cutting with shortwalls. Then, after shooting, the top may be caught by safety posts or jacks (or bolts) as soon as an appreciable area is exposed by loading. Thus, support is provided whenever there is an opportunity for installing it.

Operator protection. Protection for loader and miner operators who are relatively far back from the face, commonly is provided by bolts and/or crossbars spotted over the machine and either left in place or moved up. Use of bars of course is dependent upon sufficient height for clearance. Handling bars in the face zone, particularly where they are moved ahead each time a cut is made, is somewhat of a problem, particularly, if metal or heavy wood is needed for strength over the necessary open spans. As a result, a number of operators employ aluminum H-sections which are both stiff and light for high holding power and ease of handling. One mine, as an example, keeps two such bars in each place, moving them ahead when each cut is completed.

PILLAR SUPPORT—In addition to the regular protection of men, machines and working places, support in pillar sections usually functions as a top-breaker also. Coal itself is a form of support, either as stumps, wings, thin straight fenders, or sawtoothed fenders made by gripping or cutting out on the gob side, as examples. Frequently, a part or all of this coal may be recovered, and even if it is not, it represents a support cost considerably less than the conventional timbers or cribs. Artificial support, as in solid work, consists of jacks, posts, bars and bolts used much the same way, plus cribs and breaker timbers, both the latter primarily to break the top and at the same time protect rooms and pillar places against the riding over of caves.

Heavy weight or other special conditions may warrant special measures in roof support during pillaring operations. At one mine, as an example, the first step in mining a block open-ended is to crib it on the two sides next to the gob, supplementing this with similar cribs on a number of neighboring blocks.

Overburden at this operation ranges up to 1,500 ft in thickness and the immediate top is 40 to 80 ft of sandstone. At another property, the machine operator is protected in recovery of the final corner stump at the intersection of the pillar split and room by erecting cribs on each side of the space in which the machine advances in the stump.

ROOM AND ROOM-ENTRY SUPPORT—Depending upon equipment and mining plan, "permanent" room and room-entry timbering starts at from one cut up to 25 ft back of the face. Usual types are posts with or without capboards or short headers, and three-piece bar-and-leg sets. With topcutting in thick coal, legs may be eliminated by gripping out with the cutter bar to form slots into which the bars may be slid. Installation practices include placing all single posts on one side of the place to leave the other rib free for slabbing or pillaring.

STEEL SUPPORTS—Roof jacks until recently have been about the only substitute for wood posts in working places. Old rail has been used in the past and some attempt has been made to employ light shapes, corrugated strips and other steel members.

The advent of the coal planer and similar types of equipment brought the European-developed steel posts and steel post-and-header combinations into the picture in the United States. Their main application is on planer and slicer faces, but they are being considered in some quarters for certain other applications. Design features leading to such consideration included high load-carrying ability, provisions for yielding and thus guarding against sudden collapse through support breakage, and quick installation and release.

Timber Economics

If a place makes 25 tons and a post costs 75c to buy and the same to install, the cost per post is 6c per ton. Therefore, particularly where support recovery is not contemplated, support methods, materials requirements and possible recovery should receive intensive study.

Elimination of fatalities and injuries, and the promotion of efficient mining are, of course, the overriding goals and should not be jeopardized by stinginess in timbering. However, since even saving one post per cut amounts to considerable money per ton, a change in the posting pattern—perhaps by staggering, as an example—can achieve this saving and still provide the requisite support and protection. Where bars and other more expensive items are involved, the desirability of close study and economy becomes even greater.

MOBILE TIMBERING MACHINES cut cost of adequate face support while facilitating adherence to standard plan.

HAND-PUMPED HYDRAULIC LIFTER here eases job of replacing heavy set. Truck mounting facilitates movement.

TIMBER INSTALLATION — Even though it may prove impracticable to reduce the number of timbers set—particularly crossbars—substantial economies in setting cost can be achieved by timbering machines.

In addition to mobile units, small hand-operated lifts have been developed for replacement and installation of cross bars in entries and gangways. They are designed for mounting on one end of a flat-bed car or truck.

Even without special machines, the timber crew's work can be lightened and its capacity increased by the use of timber jacks to take the manual labor out of raising crossbars. And in thick coal, where universal cutters are employed, the cutter bar may be pressed into service to lift bars into place.

SALVAGE—The practicability of recovering posts, bars and other timbering material depends on (1) whether it is safe, (2) whether, as with the customary untreated material, decay has left it with little useful life, and (3) the cost of recovery. If these and other questions can be answered affirmatively, recovery can then proceed, but only on the basis that adequate temporary support be installed before the post or bar is removed, or that removal be done from a safe point.

Removal sometimes is synchronized with making falls in pillar mining. Supports may be pulled one by one from a remote point using the old-reliable hand-operated postpuller, or "sylvester." Greater economy and the ultimate in safety is achieved by pulling supports in groups with a power winch, wire line, and chain or chains. Some coal companies, for example, have mounted motor-driven winches on old locomotives to convert them into mechanized pullers, while others have put the winches on crawler-type shortwall trucks.

TIMBER RECOVERY is facilitated by power winches mounted on crawlers or built onto gathering locomotives.

Even with the best of equipment, recovery is only a fraction of the total timber installed, though a sizable one in many instances, with consequent overall reduction in cost of posts and bars. In some instances, posts and bars have been reclaimed and re-used as many as five times.

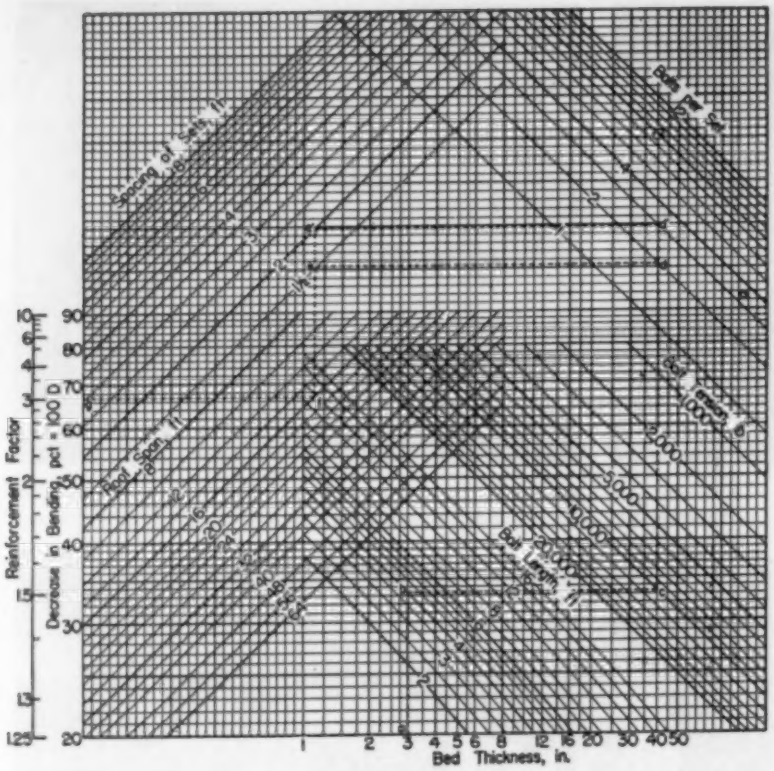
Roof-Bolting

BOLTS broke into coal mining as a means of roof support in solid work. They then moved into support in pillaring and also are used to prevent heaving of bottom and the sloughing or caving of coal or rock ribs in shafts, slopes and entries. Bolts, however, are not a universal curve-all for roof troubles, and conventional timber or a mixture of bolts and conventional timber may be better from all angles under certain conditions.

Bolt Types

Roof bolts normally function by pinning a number of weak members together to form a strong beam. A somewhat rare function is hanging loose lower members to a strong upper member. In beam-building particularly, the desired result is attained by anchoring the bolt and then screwing a bearing plate up against the top. This, it will be recognized, puts the bolt in tension and makes the beam-building action possible. Unless the bolt is tensioned, there is no beam action, and unless tension can be achieved, meaning that an anchoring stratum or horizon must be found, other means of support normally must be employed.

The object in bolting is reinforcing the roof and thus increasing its resistance to sagging and failure. If the roof is good it may be necessary to increase its



BOLTING DESIGN CHART developed by U. S. Bureau of Mines facilitates design of bolting systems which provide the required support with a minimum expenditure for bolting materials.

natural resistance to failure only one-half, as an example, meaning that only a minimum of support is necessary. But as its natural resistance to sagging and failure decreases, the reinforcement factor increases. Thus, for top that is inherently weak, it may be necessary to install support that will multiply its natural resistance to failure as much as 3 to 4 times.

SPLIT-ROD-AND-WEDGE — Properly installed in rock of the right type, load-carrying characteristics of the split-rod-and-wedge bolt are excellent. It is easy to install and is not weakened in the installation process. However, it requires compressed air for driving and thus may require the purchase of compressor equipment. The extra step of driving the bolt into the wedge increases installation time approximately 20%, and cost of materials usually is higher. It loses its holding power more readily in the softer, semiplastic rocks and protruding bolt ends are a hazard, though they may be clipped off with special bolt cutters.

EXPANSION-SHELL — Requires no driving to anchor, is better suited to softer semiplastic rocks, is normally cheaper—about 25%—and can be installed in shorter time. However, it is more difficult to tension properly, and maintenance of tension is difficult in soft material.

BOLT SIZES—The usual sizes of bolts today are ¾ and ⅞-in. The ⅞-in bolt in high-strength steel has a maximum yield load of 9,040 lb, compared to 10,020 lb for regular-strength steel in the ¾-in size. In the ⅞-in size, the weight of 100 4-ft-long bolts, rolled threads, unchamfered square heads, is approximately 350 lb. The weight of 100 of the same bolts in ¾-in size is 510 lb. Thus, with the same holding strength the saving in steel is nearly 30%.

Plates usually are 6x6 in, though other sizes are employed. Embossing can give the same bearing strength with a considerable decrease in thickness, and consequently such plates are used by a number of producers.

The ⅞-in bolt, incidentally, offers another advantage where tension dropoff is experienced as a result of plastic flow of top materials, movement of top strata and/or shrinkage of headers (*O-B Haulageways*, September, 1956). This reflects the fact that the ⅞-in bolt has approximately 42% greater linear deformation than the ¾-in regular. Thus, if a 4-ft bolt of each type was installed to a tension of 10,000 lb, and roof movement later reduced the stretch in each by 0.030 in, the tension would drop to the following: ¾-in, 3,600 lb; ⅞-in, 5,300 lb. The higher figure for the ⅞-in, bolt might mean the difference between failure and continued holding of the top.

CEMENTED BOLTS—A recent introduction is the cemented bolt. Cementing naturally increases the cost substantially but does insure a permanent anchorage, especially in soft strata. It is offered primarily for long-lived permanent openings where the extra cost is less a factor.

The design (*Coal Age*, May, 1957, p 120) is based on the use of a reinforcing bar instead of the conventional bolt, plus a perforated sleeve. The sleeve is placed in the hole and filled with mortar. The reinforcing bar is then driven into the sleeve.

Bolting Patterns

As with timbering, the pattern with bolting must be adjusted not only to conditions at each mine but also to variations within each mine. And since an individual bolt in place seldom costs less than $2, including equipment maintenance and depreciation, etc., saving even one per cut, provided safety is not jeopardized, is a worthwhile economy. By the same token, auxiliary forms of support should be omitted unless they contribute significantly to holding power and safety.

Where bolts are used alone, a check of published descriptions apparently indicates that the majority are placed on 4-ft centers, compared to 4 to 5 ft with crossbars and individual posts. Special patterns for long spans or weak top include the "Star" (a bolt in the center of a four-square pattern). Also, under some conditions, making part of the bolts—say every other one—longer may be helpful.

SUPPLEMENTARY SUPPORT — Even though bolting is one of the best support systems yet devised for holding the immediate top, which is its major function, it is manifest that bolting alone is not the answer to all support problems. One evidence is the occurrence of major roof-fall disasters where bolting patterns were considered satisfactory. True, the number of such falls has not been large, but they have helped focus attention on the following points:

1. The need for auxiliary timbering in many mines to help support the top and equally or more important to give warning of impending collapse.

2. The need for careful checking to keep track of changes in roof conditions so that the support system can be modified to compensate.

In fact, in a few instances, it has been

found that conventional timbering is more reliable, easier to install and cheaper, in addition to the support and warning features, plus, in some instances, increased salvage of support material.

The type of roof has some bearing on the type of the supplementary support. For instance, with a strong anchoring member not too far up but with a tender roof immediately over the coal, or one that contains slips, cleavage cracks, kettlebottoms and the like, the bolts themselves may be used as the mounts for the additional support. This additional support takes the form of wood blocks, headers or crossbars, as well as metal auxiliaries, including steel channels, steel ties, heavy wire mesh, aviation landing mats, and so on.

Where there is a question of anchorage, or where there is doubt about the strength of the beam created by bolting, support independent of the bolts may be necessary. This takes in all the conventional forms, including single posts, bars and so on, including such special types as a crossbar held by a bolt at one end and resting on a post at the other. The latter practice was developed for pillar work, the post being set on the solid side to act as a breaker when the next lift is taken.

Continuous-Miner Plans

The continuous miner presents some tough problems in achieving support without interruption, and these problems are accentuated when conveyors are used for transportation. In return, however, certain miners contribute a benefit in the form of arched or elliptical openings which definitely increase the resistance of the top to sagging and failure.

Unless concurrent bolting is practiced, interruptions in the operation of the miners are almost inevitable if the operator is to be protected at all times by support. Consequently, the usual practice is to advance full-face machines to the point where the operator is under or only slightly beyond the last support, whether it be bolts, posts or bars. This means that the usual advance is 18 to 20 ft, after which the machine is moved back and the newly exposed area is timbered or bolted. An alternate place or places cuts down on the loss of time if the moving distance is not too great.

ALTERNATE ADVANCE—If the machine is not a full-face unit, the practice is to alternate advance from one side to the other. If a full-width cut is taken on each side it sometimes is feasible to bolt one side while the other is being advanced. Adjusting length of advance to bolting time makes it possible to synchronize so that the miner operator is never out from under protected top. If the place is being cut only head width, or width-and-a-half, it usually is necessary to stop and pull back or move to another place to permit bolts or timbers to be installed.

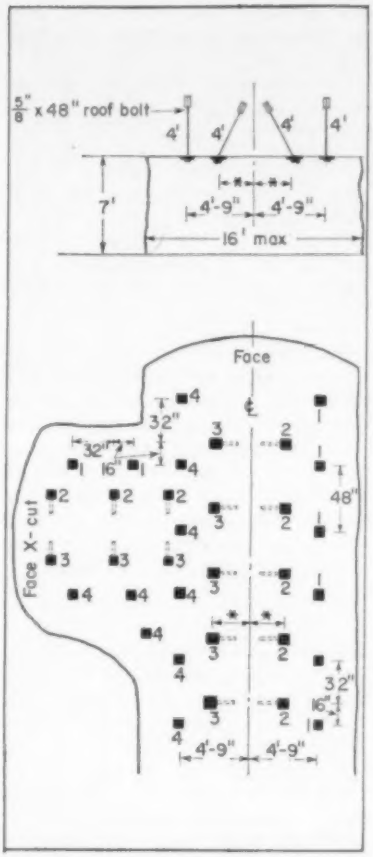
BOLT CENTERS—Bolts usually are placed on 4-ft centers with continuous miners; bars on 4- to 5-ft centers, where used. If single posts are employed, they usually are set in a row or rows equally spaced from both ribs, leaving a roadway in the center. With certain types of miners recessing of bolt heads and plates into the top is being practiced at some mines to keep them from interfering when a cross-cut or pillar place is started.

Where only rooms are mined, some operators use the adjacent place as storage for bars, props and jacks. One, as an example, uses jacks and bars, picking them up from the preceding place as each crosscut is reached.

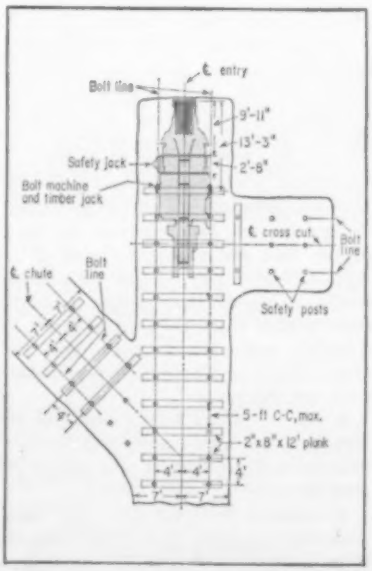
PILLARING METHODS—In pillar extraction, conventional bolting or timbering plans can be followed where pockets are driven and stumps are left against the gob for final recovery or crushing. In open-ending it may be desirable to adopt a special plan. One, for example, more suitable for full-face units, involves cribs and breaker posts to protect the open lift until extraction is completed. Another is based on bars bolted at one end and supported on a post or posts at the other—usually next to the gob. This system it will be noted, would be more adapted to ripper-head or to other non-full-face units. Or, the latter procedure might be reversed to put the posts on the solid side so that they could serve as part of a breaker installation for the next lift.

CONCURRENT BOLTING—Bolting units have been devised for installation on all types of miners, whether ripper, semirigid head or boring type. The mounts normally permit angling the drill in or out a maximum of 25 to 30 deg. The usual practice is to swing the unit out on one hole and install the bolt, and swing it in on the next, thus getting two rows on each side of the place, unless only one row on each side will suffice.

The key is sufficient speed in bolting to permit the job to be done before the machine has to move, if it is of the ripper or semirigid type, or until it advances beyond the slide or arm range of the unit on boring types. Normally, sufficient time is available to permit a good job of bolting, which can practically eliminate stopping the machine to install supports. The additional production can be as much as 20 to 25% where such bolting is possible. In addition, no member of the crew is exposed to open top with some types of installations, and



VERTICAL AND ANGLED BOLTS are involved in this concurrent plan for ripper machine. Bolts are set not over 4 ft apart.



PLANKS SUPPLEMENT BOLTS in this concurrent plan for drawslate and weak roof members. Safety jacks and bars protect bolters.

only the bolters with others. Even then, the bolters are some 12 ft or so back from the face.

Two concurrent systems are shown in the accompanying illustrations. In brief they are:

Vertical and angled bolts. Two 4-ft-long ⅝-in bolts with expansion shells are set for each 18 in of ripper-machine advance. One bolt is angled over the machine and the other is installed vertically, the two bolters alternating. Maximum bolt spacing is 4 ft.

Bolts and planks. Developed for use with a weak drawslate occurring with other weak roof members, this plan involves 2x8-in planks 12 ft long installed with ⅝-in 1040-steel bolts 6 ft long. The bolters are protected by a pair of steel rails on jacks ahead of the bolting stations. The planks provide excellent support and also a very-evident warning if trouble is impending.

CONCURRENT TIMBERING — In addition to bolting, concurrent timbering is being developed to prevent waiting or moving. Posts or posts and bars are installed in conventional fashion in cycle in the usual system. Special systems, however, include hitching on one side and supporting bars on posts on the other. In one instance, a boring-type miner was equipped with cutters making a 6-in slot 18 in deep on the hitch side to accommodate 4x14 H-beams 15½ ft long, using a post and wedge at the opposite end.

Designing Bolting Systems

Based on the results of model testing (USBM R.I. 5155, "Design of Bolting Systems," and 5156, "Reinforcing Bedded Mine Roof With Bolts"), the Bureau of Mines has developed a general procedure for designing a bolting system. Based on a roof-bolting design chart, illustrated, the procedure is:

1. Take as a first approximation of average bed thickness a figure arrived at by dividing the observed thickness of the roof section by the number of separate laminations. Use of the average results in conservative design. Laminations thicker than the average result in a higher reinforcement factor than the chart, which applies where all laminations are the same.

2. Choose a bolt length that will assure firm rock at the anchorage horizon. This may depend upon the results of tests (Item 3).

3. Conduct tests to determine bolt-anchorage capacity (R.I. 5040, slotted-type bolts, and R.I. 5194, expansion-type). Choose as the design value for the bolt tension either the anchorage capacity or the following, whichever is smaller: 10,000 lb for a wedge-type mild-steel bolt or 8,0000 lb for a ¾-in mild-steel expansion-shell bolt. However, if experience shows a significant loss of tension after installation—say to 5000 lb a month later—this lower figure should be used.

4. Choose the number of bolts per set so that the spacing within the set (span divided by the number) is not excessive. For most mines the maximum safe distance between bolts is estimated at 4 to 6 ft. The minimum bolts per set can be determined from roof-condition experience at the particular mine. A logical procedure would be to decrease the bolts per set in steps, each time decreasing the spacing as required by the design chart to keep the reinforcement factor unchanged. Bolt-to-bolt and bolt-to-rib spacing should be approximately equal in the set.

5. Choose a trial value for spacing between sets along the opening not greater than the spacing across the opening within the sets.

6. Using the desired roof span, construct the line A-B-C-E-F-G on the chart.

7. If the reinforcement factor is less than 2, decrease the set spacing and/or the roof span, and increase the number of bolts per set and/or the bolt length. A change in spacing and/or span will have a greater percentage effect.

Results achieved in bolting a particular roof should indicate whether the existing reinforcement factor, as determined from the design chart, is adequate or should be increased by modifying the existing bolting system. In the absence of previous experience the minimum reinforcement factor should be 2; otherwise bolting is not justified. Conversely, if the existing bolting system is judged to be effective, the design chart may be used to develop a system that is less costly.

Bolt Installation

Split-rod-and-wedge bolts require a percussion tool for installation, which in turn requires compressed air.

Air still is the preferred medium for drilling the hard rocks encountered in mine roofs, even though electric rotary drills have been taking on harder and harder material. Portable compressors are widely used, though central stationary units have their advocates, who state that the advantages include plenty of air at rated pressure, lower maintenance and less trouble with dirt and water in air lines.

Portables may be mounted on rubber or crawlers, or may be carried in shuttle cars. They may be sized to operate one or two stopers, but in any event they should be capable of supplying drilling needs without drop below rated pressure.

Rotary Drilling—Ability to vary speed and pressure is a very desirable drill characteristic. In soft drilling, high speed and low pressure usually give the best results. In hard cutting, reducing rotational speed and building up pressure results in better cutting, especially with the proper design of bit head.

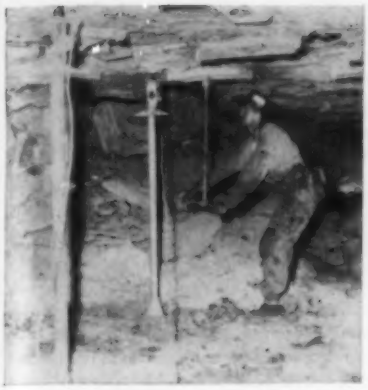
Length of drill should be as short as possible for maximum strength. Ejection of material in rapid drilling may make the use of a conveyor-type auger desirable. Spiral flights may also serve another purpose, i.e.: eliminating the offsets which tend to occur when passing from soft to hard rock, with subsequent breakage of bails as the bolt is run up. Spirals almost the diameter of the hole prevent this occurrence.

Proper operation and maintenance of rotary and other type of roof-bolters have a significant bearing on costs and results. If possible, the manufacturer should be afforded an opportunity to explain the operation of the machine to the maintenance superintendent, foreman and driller, with special attention to showing the driller the relation of thrust and rotation to penetration and bit wear.

Regular inspection, proper lubrication and cleanliness are basic approaches to the problem of keeping maintenance down. Also important is having the maintenance superintendent and manufacturer determine proper pressure adjustments. Pressures should be checked regularly and should be adjusted for changes in roof conditions.

Bits—Drilling with dull bits results in overheating and damage to the bits, in addition to damaging machine parts because of excessive stresses. Bits ground off-center or with one short cutting lip result in hole enlargement, making proper anchorage impossible in some materials. The same effect also results from allowing bits to spin or "dwell" too long at the anchorage horizon. Worn bits, loose-jointed drill extensions or drill whip can result in undersized, "dog-legged" or rifled holes.

1. **Work with bit manufacturers** to get the proper carbide and design.
2. **Consider the use of two or three sizes of bits** to reduce wear through loss of gage and speed up drilling.
3. **Match thrust and rotational speed** to conditions for maximum penetration and minimum bit wear.
4. **Employ trained men** for sharpening and reconditioning bits.
5. **Keep a bit-sharpening record,** and a record of holes drilled and bits lost or destroyed.
6. **Determine bit needs** per shift, all sizes.
7. **Provide driller with two strings of bits** so that while one string is in use the other can be sharpened.
8. **Use bit record** to determine if the

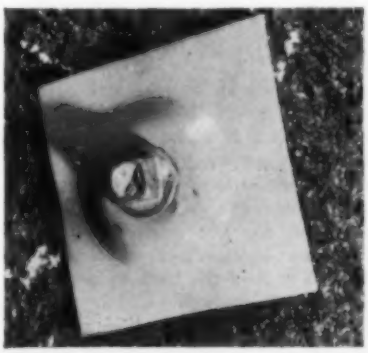
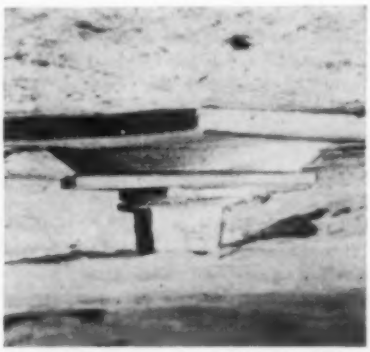
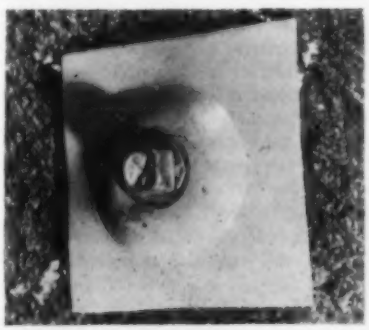
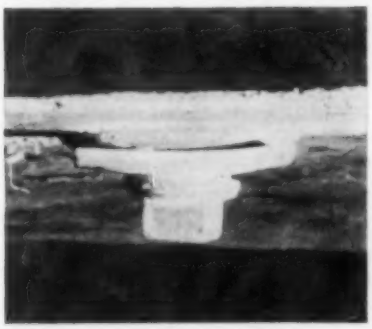


BOLT RECOVERY with special jacks designed to be tripped and pulled out by ropes make the job easier, simpler and safer. Recovery stages using the jacks are shown in the three photos above.

machine needs adjustment, roof conditions are changing, or the driller needs instruction.

DUST COLLECTION—Of the two main methods of suppressing dust—water during drilling and dry collection—the latter is forging ahead because of the inherently greater complications of water. The simplest form of dry collector consists of a flexible collar held against the roof to collect the cuttings and drop them into a bag or onto the floor. More positive means of collection and disposal are provided by vacuum units operating through collars around the drills or, in the latest, by pulling the cuttings through hollow bits and drill steel.

Dry dust collection, however, has been found inadequate under some conditions though normally it is generally preferred. Drilling in hard sandstone at one operation, as an example, became impracticable with dry collection. Tanks and pumps were installed to feed water up through the hollow drill rod, making it possible not only to drill the rock but rendering dust collection unnecessary.

VISUAL EVIDENCE of bolt tension is provided by new indicators. The type at the left shows by flattening of the crimp in the washer when proper installation tension has been reached. The type at the right (flat at proper tension) also shows if bolts have lost tension after installation by flipping back to original shape.

ANCHORING AND TENSIONING—Anchorages vary in accordance with the type of rock, with corresponding effect on the maximum tension possible. And without anchorage there is no possibility of achieving tension and consequently there is no reinforcing effect. Naturally, other things being equal, a better anchorage can be achieved in hard sandstone. In fact, in such material it is possible to break the bolt before it pulls out. In soft shale, the opposite is the case and the bolt will pull out before it will break. However, a certain degree of tension can be achieved even in soft material and this frequently is enough for the purpose, or enough to reduce the need for supplementary timber.

Correct hole size is a major factor in good anchorage and ability to tension properly. Undesirable variations include oversize, undersize, "dog-legging" and rifling. Periodic checks with a hole gage is a major method of revealing such faults before they become serious enough to cause trouble.

Proper installation is another factor in good anchorage. With expansion-shell types, this includes positioning of the expansion units so as not to use up thread and thus increase the possibility of not being able to develop full tension because of running out of thread. Check plug and shell position periodically by removing sample bolts to see that proper anchorage is being achieved.

CEMENTED ANCHORAGE—A new development in anchoring expansion-shell bolts is enclosing the shell in an envelope containing a quick-setting plastic cement. As the bolt is run up the envelope is punctured and the cement fills

the hole and hardens for a firmer anchorage in any type of top.

TORQUE REQUIREMENTS—Under average conditions, 50 to 80 lb of tension is developed for each foot-pound of torque. If 60 is taken as a conservative factor, about 150 ft-lb of torque will develop 9,000 lb of tension—well below the yield point of a ¾-in mild-steel or ⅝-in high-strength bolt, assuming the bolt bears against a plate that is level and that there is not excessive upward pressure to generate additional friction.

Torques up to 200 ft-lb may be employed in hard material, with some authorities suggesting around 170 ft-lb in hard shale and 150 to 160 in soft shale. In very soft top, where anchorage capacity is limited, bolts may be tightened with a hand torque wrench to determine the suitable setting for the bolting machine.

Bolt head and roof plate should be firmly against the top before tightening begins to make sure that the maximum thread length is available. Excessive torque may be wasted in hard top as a result of galling between bolt head and plate. If the plate is not level the bolt head may be twisted off at over 175 ft-lb.

Caution should be observed with wood headers to make sure that tension is preserved. Wood can dry out, yield under pressure and otherwise change characteristics with loss of tension. Never install a wood header, crossbar or capboard with a nut alone. Always use a steel bearing plate.

Other factors involved in good anchorage and tensioning include machines in good adjustment and the use of the correct bolts, shells and washers for the job.

CHECKING TENSION—The ultimate in accuracy and perhaps the best method of determining the efficiency of the bolting job is the pull test with a hydraulic ram. Between such tests a hand torque wrench should be employed at frequent intervals to check the accuracy of the torque setting of the wrench or bolting machine.

After installation bolts may lose tension for any of a number of reasons, including plastic flow of the rock at the anchorage point, movement of the strata, drying out or yielding of the headers, crumbling of protuberances under the bearing plate and so on. As noted, the handy device for spot checking to see if a tension dropoff warrants retightening is the hand torque wrench.

VISUAL INDICATORS—Two general types of indicators to show tension in bolting are now available. One shows only that initial tension is secured, and consists of a crimped washer, the crimp of which disappears when the correct tension is attained.

The second type shows not only that initial tension has been secured but also if any relaxation takes place in service. Such indicators, because of their cost, normally are designed for installation on approximately every 10 or 12 bolts. One device of this type consists of two circular plates between which a layer of rubber has been bonded. As the device is placed under tension of compression the rubber expands or contracts, and the relationship between tension and torque, or the relaxation of tension in use, can be determined by using a special compression-pad gage.

The second indicator comprises specially forged self-centering-head bolts, specially embossed plates and concave steel-spring washers. They change shape as the load is applied and change back when tension drops to a certain value.

Bolt Recovery

Since, as with timbering, except on pillar lines, it is estimated that not more than one bolt in 10 is ever called upon to actually support top material, salvage almost automatically becomes a matter for consideration, since whether the bolt is holding top is a major factor in determining whether recovery is possible. Even if most of the bolts were supporting top, salvage would still be possible by installing protective support, but the hazards are substantially greater and the savings possibilities correspondingly less.

Recovery operations so far are limited almost entirely to the expansion-shell type of bolt. Under favorable conditions, recovery cost is ¼ to ⅓ the cost of a new unit, including expenditures for new shells and nuts.

Hand salvage is the rule, and a basic principle is setting roof jacks or safety posts before any attempt is made to remove a bolt. A special jack now available can be tripped and pulled out by a cord (see accompanying illustrations; also *Coal Age*, January, 1959, p 120).

A second principle is at least two men to a salvage crew, since two heads can be better than one in guarding against hazards, and the second man, in case of trouble, can, in many instances, prevent an accident from turning into an injury or fatality. Experience so far indicates that a two-man crew can recover 200 to 300 assemblies in a shift.

Mechanized recovery units have been developed for some operations. In one, a standard drill with appropriate socket is installed at one end of a rubber-tired truck with the operation switch at the other. Thus, the men are back of at least two rows of bolts when removal takes place, and consequently do not need to set as many safety jacks or posts. With two men, it was reported, recovery was running 300 bolts per shift. No recovery is attempted under bad or doubtful roof. After the drill loosens the bolt, it is pulled out by means of a piece of copper tubing about 6 ft long.

Coating and Sealing

THE SUSCEPTIBILITY of certain types of roof to changes in moisture and temperature is so pronounced that a number of deep mines in the past have installed elaborate conditioning units to insure uniform humidity and temperature. More recently, even though the idea is old, a number of operators have turned to coating and sealing to prevent roof and rib deterioration as a result of these influences.

Coating and sealing products include vinyl compounds, coal-tar products and mastic-type materials—all sprayable with or without heating, usually because they are dissolved in a volatile compound which evaporates after application. Because solvents normally are flammable or explosive, or both, care must be taken in application. Also, care must be exercised to see that after application the material will at least not propagate fire even if ignition cannot be prevented. A number of products now on the market meet this standard and are being employed.

Careful scaling and dryness are major prerequisites to good sealing. Though it provides no support, sealing has cleaned up some very costly roof and rib disintegration situations at a number of mines where conventional timbering failed to do the job. Cost varies from 15c to 20c per square foot minimum at most operations, including scaling and other preparations. Usual practice is to seal the top and carry the coating 6 or 12 in down each rib for insurance. At some mines, all the coal ribs are sealed to prevent sloughing. One of the incidental benefits is a smoother surface, which helps ventilation.

Injection Bonding

The major objective in bolting, as previously noted, is binding several thin, weak layers together to make a thicker, stronger roof beam. In essence, the process is the same as making plywood, which logically led to the idea of bonding roof members together much as the plies are glued together to make plywood.

The bonding is done by injecting the bonding agent under pressure through drill holes at appropriate intervals and of appropriate depth. Experiments so far (*Coal Age, January, 1958, p 116*) indicate that the idea has good possibilities. If further work confirms this, bonding may be the new and more-efficient approach to reducing or preventing roof falls.

The Deep-Mining Guidebook . . .

Transportation with Economy

Major Aim

A haulage system with the capacity and reliability necessary to take all the coal the face units can provide with no interruptions.

Collateral Aim

Facilities and equipment that represent the minimum in investment, require minimum operating labor, are safe to use and are low in maintenance cost.

Approaches

Install equipment with the necessary capacity to handle normal peaks in addition to the regular-rate flow of coal.

Eliminate interruptions or reduce them to negligible figures by such things as conveyors of the extensible and bridge types, pickup loaders and high-capacity haulage units.

Automate, as at transfer pints, use big units and take other steps to reduce haulage labor.

Face Haulage

ALTHOUGH MINE CARS have moved into a minority status in serving face units, some of the lessons learned in attaining maximum efficiency with them apply with equal force to their successors. One lesson is use of the biggest car possible to cut down the number of changes and thus increase loading time. A second is a haulage layout providing at the best a changing point no further back than the next crosscut, and at the worst no farther than 150 to 175 ft back. One contribution to the short change with cars was the development of prefabricated track layouts, which practically guaranteed a changing point at every crosscut.

Shuttle Cars

As with mine cars, the bigger the shuttle car, within limits set by seam and other conditions, the fewer the changes and consequently the fewer the interruptions in mining and loading at the face. Also, as with mine cars, the closer the changing point, assuming the usual two and sometimes three cars per unit, the higher the efficiency.

New types of cars include the 6-wheeled unit hinged in the middle to increase capacity in low coal.

Regular AC and torque-converter cars not only offer advantages of simplicity and low operating and maintenance costs, but facilitate AC use.

SURGE CARS, PICKUP LOADERS—To compensate in part for the interruptions inherent in hauling with wheeled units, some form of storage may be provided behind the loader or miner. The mine bottom is one form of storage, in turn bringing in the pickup loader. Even with the cost of the loader and operator, the increase in miner performance has been sufficient in many instances to show a handsome gain.

The surge car is a possibility under some circumstances but is not a cureall. The car may be a standard shuttle car or a specially built unit. Whether to use a surge car can be determined only after a careful study.

Where to Find It

Face Haulage . . . . . p 245
Shuttle cars . . . Battery tractors . . . Conveyors . . . Extensible conveyors

Trip Loading . . . . . p 249
Trip movers . . . Track layouts . . . Automatic loading . . . Switching coal

Main Haulage . . . . . p 249
Rail haulage . . . Track . . . Haulage control . . . Belt haulage . . . Belt operation

Hoisting . . . . . p 252
Belt slopes . . . Shaft hoisting

Handling Men . . . . . p 253
Hoisting . . . Car transportation . . . Belt

HAULAGE LIMITS—The maximum length of shuttle-car haul is approximately 500 ft with two cars per face unit. The tendency, however, is to keep the maximum under 400 ft where possible because of excessive loss of miner or loader working time as room depths near their limit. This may be offset in part by introducing a third car, which, however, requires extra investment in equipment and labor, and very careful organization of the haulage system to prevent interference. However, some operators use the third car quite successfully. One, as an example, operates the third car as a combination unit. In other words, it works part of the time moving coal and part of the time bringing in supplies.

The cable-reel limit can be stretched by anchoring the cable at the midpoint and backlashing on half the run. Some operators who have tried it recommend against the practice not only because the long hauls raise loader waiting time, but because backlash reeling is more difficult and is harder on cable, guides and reel. Therefore usual practice is to anchor at the discharge point. Shock-absorber-type anchorages are great cable savers, incidentally.

Though the ultimate savings at any particular operation depend upon the mining plan and conditions, the possibilities in keeping shuttle-car distances short may be substantial. For example, extra moving of transfer stations to keep distance down by 200 ft per round trip might cost, say, 1½c per ton, while the reduction in face cost as a result of higher machine output might be 10c. Separate travelways, where possible, also contribute to speeding up shuttle-car service and thus increasing face output. Under at least some conditions, as shown in accompanying diagrams it is possible to arrange hauls so that it is never necessary to go through curtains or doors.

TRANSFER TO MINE CARS—Unless the track is sunk, an elevator or ramp is necessary for transferring from standard shuttle cars to mine cars. Sinking is done at some mines, and normally where this is the practice an effort is made to have one station serve places in both sides of an entry. The same practice also is followed where the top must be shot to permit the use of elevators or ramps. To keep the shuttle-car haul down to the minimum, stations normally are established at intervals of 200 to 300 ft. And also to reduce top-shooting as much as

Field Reports

Ropeframe Belts—Report on experience at the mine where the rope belt was pioneered, taking in mainline and panel units. Saving in installation of 4,000-ft mainline unit estimated at $50,000, compared to conventional unit. *Coal Age*, February, 1958, p 124.

Beltman's Guide—How to install and operate belt conveyors; how to troubleshoot conveyor operation and belting difficulties. *Coal Age*, March, 1958, p 122.

Low-Labor Haulage Design—New cars, welded track, automatic dump and new belt slope feature system handling 3,300 tons in two shifts with four men. Results include 50% reduction in haulage cost and 29% boost in overall productivity. *Coal Age*, July, 1958, p 66.

Slope Haulage With Cable Belt—Three years of hoisting with first North American unit showed almost no difficulties in handling 1¼ million tons. Belt length is 3,800 ft between pulleys. Vertical lift is 693 ft and peak capacity is 750 tph. *Coal Age*, September, 1958, p 106.

New Cars Cut Haulage Cost 33%—Replacing old 90-cu ft cars with 262-cu ft modern units cuts overall mining costs 5% in 34-in coal. *Coal Age*, October, 1958, p 108.

Battery Tractors and Trailers—Rubber-tired tractors and 1¾-ton trailers increase output for thin-coal trucks mines. *Coal Age*, January, 1959, p 86.

Modernizing Haulage and Dumping—New rolling stock and dump cut haulage cost 47% and dumping costs 51%. *Coal Age*, March, 1959, p 94.

Automatic Car Loading—Electrical and mechanical design details for automatic belt-to-car transfer station. *Coal Age*, April, 1959, p 97.

possible, at least one operator has developed a low-type elevating unit mounted on a crawler-type mining machine truck (*Coal Age*, September, 1955, p 72). A high-speed conveyor is provided to eliminate slowing down or stopping shuttle-car discharge. In this instance, transfer stations are prepared by the development crews every 120 ft.

Making it possible for the shuttle car to discharge at maximum rate without stopping is, as noted, a major element in keeping an operation up to maximum efficiency. If elevator capacity is low, a hopper should be provided—usually by sinking the boot into the bottom. Or the chain should be speeded up. Provision also should be made for changing mine cars without stopping the elevator or shuttle car. Making shuttle-car and mine-car capacity match is one method being used at new mines or where cars or shuttle cars are being replaced. This method is especially effective with elevating-discharge cars, but works well with any other type of transfer equipment.

TRANSFER TO BELTS—A number of mines apparently encounter little difficulty in side loading belts from shuttle cars, but a greater number limit belt loading to end-on only, with usually a special hopper or a hopper-tailpiece combination to start the coal on its way. Side loading, these operators contend, results in greater spillage and, because the coal comes on at 90 deg, is harder on belts.

Where side loading is practiced, with the belt in the center of three headings, it is possible, by assigning a crosscut on each side to a shuttle car, to load at four points, provided the crosscuts are offset. Also, with two cars, one may be assigned to the end position and the other to a side position in the next crosscut down to keep them apart at all times. Other systems are of course possible, and include the end- and side-loading types for three cars shown in accompanying illustrations.

In end loading, with auxiliary hoppers, there is an opportunity to install a grizzly to pad the belt with fines before the lumps hit. To load belts, either side or end, a low ramp or an elevating-discharge car is necessary. A saddle-type hopper that can be moved along the conveyor (*Coal Age*, February, 1957, p 108) can help materially when it is necessary to shift side-loading stations often.

Big lumps may be a problem in transferring from shuttle cars to belts. One answer is a portable grizzly on legs into which the car discharges. An attendant is necessary to break the lumps, but some operators believe his cost is more than repaid by less belt wear and damage (*Coal Age*, May, 1959, p 72).

Unless belt speed and width are sufficient to move the coal as fast as the shuttle car can discharge, delays are bound to occur. To prevent these, and also to improve belt-loading conditions, a number of steps may be taken. One is to install a two-speed motor with automatic timing control to speed up the belt while the shuttle car is discharging and cut it back automatically afterward.

Transfer conveyors or elevators capable of taking maximum shuttle-car discharge and at the same time designed to feed to the belt at the proper rate are used at a number of mines. Conveyors may be of the belt, chain or shaker type, with or without hopper and with or without two-speed controls. A recent unit consists of a hopper with dual conveyors converging in a throat at the discharge end (see illustration). The design automatically provides slow feeding to the belt with fast acceptance from the shuttle car.

Incidentally, where a number of elevators or conveyors discharge to a belt, it is possible to interlock to prevent simultaneous operation and over-loading of the belt by the outby unit. One mine uses a skate wheel on a flat spring under the top run of the belt (*Coal Age*, May, 1951, p 83). When the belt is loaded, the spring is depressed to hold in a button locking out all elevators except the one in use. As soon as the belt clears, the button is released to permit another elevator to start automatically.

Another system (*Coal Age*, December, 1958, p 144) also employs a wheel to sense changes in belt loading. Through an arm, solenoid-operated contactors, resistors and a shuttle-car acceleration switch three side-belt operating speeds are automatically provided and overloading of the main belt is prevented.

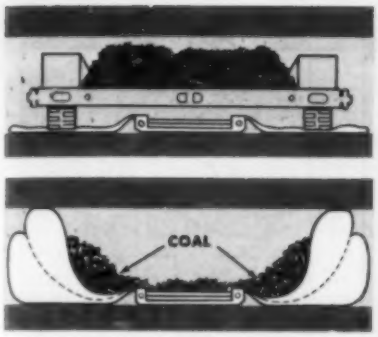
Other suggestions are finger or paddle switches actuated by being struck by coal to prevent an elevator or a crossbelt, from pouring coal onto an already loaded main belt.

SHUTTLE-CAR ROADS—Ruts, dust and mud are the major difficulties in building and maintaining shuttle-car roads. A good rut preventive used at many mines is to sling a section of light rail or angle crosswise underneath the cars and just clearing the bottom, using chain or wire rope.

Where there is much mud, planking is the usual answer, normally with 2x8's or 2x12's on stringers of the same material under the tire tracks. Spaces of, say, 3 in between planks reduce the number necessary and also provide places in which to lay cables serving other machines that might use or cross the roadway.

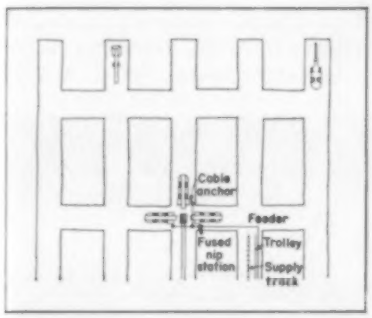
Battery Tractors

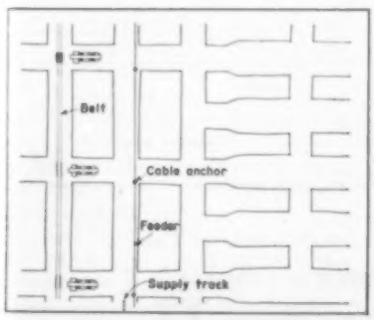
Rubber-tired trailers or trailer trains pulled by battery tractors are among the developments and modifications of the original shuttle-car idea. They were developed primarily to meet the problems



PNEUMATIC FEEDER facilitates coal transfer in low seams.

DUAL-CHAIN FEEDER for use between shuttle cars and belts automatically provides slow and fast rates.





END AND SIDE DISCHARGE for shuttle cars to belts. All cars have their own routes. Three cars can be accommodated.

of the small drift mines in coal under 36 to 40 in, with some in 24 in or less.

Before the train idea was evolved, a number of designs for a low-cost shuttle car for such operations had been developed. Also, tractors were developed for pulling bottom-dump trailers.

The battery tractor is used to pull up to 10 trailers (*Coal Age*, January, 1959, p 86). It acts like a gathering locomotive also functioning as a mainline haulage unit. Both three-wheeled and four-wheeled trailers with lift endgates are used.

Conveyors

BRIDGE CONVEYORS—By providing a continuous and continuously functioning connection between loader and room conveyor, and by relieving the operator of all but the responsibility for keeping the machine in coal, the bridge unit has resulted in major increases in tons per man at the face. A typical bridge plan appears in the "Mechanical Mining Planbook" elsewhere in this issue.

Evolution of the bridge unit has included development of the tandem and mobile bridges, the latter being able to advance and retreat under its own power. Both chain and belt types are now available, and may be connected to the face unit by a suspended bridge or, as with one type of belt, may take feed from shuttle cars, thus reducing the number of transfer-station moves. These units also are known as "mobile chain feeders" and "mobile belt feeders."

One combination of bridge and other units providing 150 ft of room between a mobile chain feeder and the face is made up of the miner, a pickup loader, a standard bridge, a mobile bridge and a second standard bridge discharging to the mobile chain, which in turn can be up to 150 ft long.

ARTICULATED AND CASCADE CONVEYORS—Development of the continuous miner and accompanying emphasis on development of conveying mediums also has resulted in the design of articulated and cascade conveyors and conveyor systems. One version of the articulated conveyor developed for a boring-type miner consists of a series of interconnected belt conveyors on wheels, each with its own driving and propelling motors (*Coal Age*, January 1954, p 84).

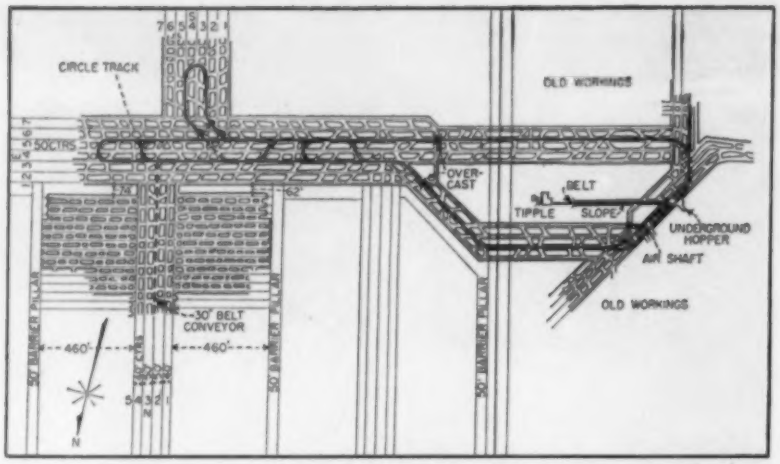
The cascade system is substantially similar, but has some differences. One is in the fact that the conveyors need not be coupled, though hitches are provided to permit the train to be pulled behind the boring unit in one remote mining system. To avoid inserting and removing conveyors one at a time, the latest idea in remote mining is to store the conveyors in a structure with circular ramps.

Extensible Conveyors

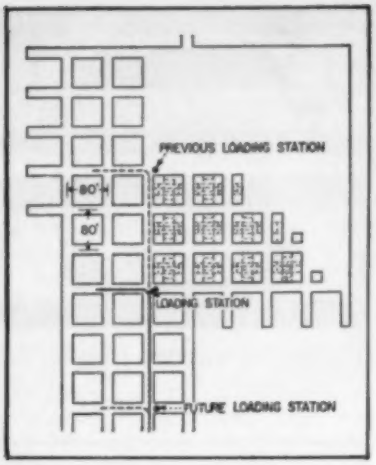
Development of the bridge unit was the first step in really bringing the conveyor into the picture as a means of serving loading machines and continuous miners. The next step was to design the room conveyor so that it could be easily extended to keep up with the face unit. The first such unit was the extensible belt, first with standard angle, channel and plate frames. Recently, the rope type has taken over almost completely.

Chain-type conveyors of the extensible type are a recent offering (*Coal Age*, May, 1957, p 111). In this unit, made up of sections mounted on rubber-tired wheels, each section has a gooseneck in the middle, with the raised rear end riding on the low front end of the succeeding section. This results in an extension of approximately 50% of the length of each section.

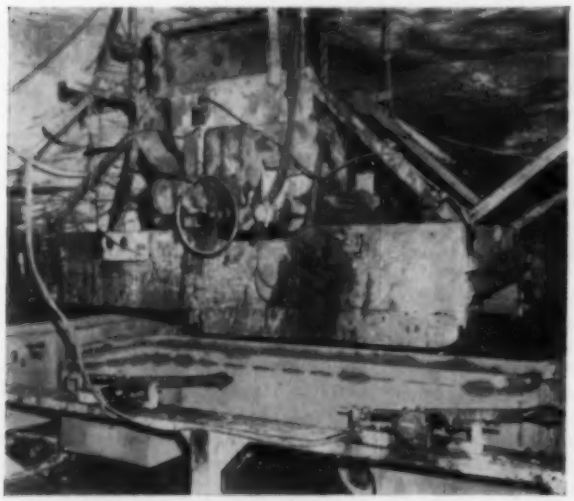
With the bridge conveyor followed by the extensible unit, a continuous conveying route is provided from the mining unit to the transfer point or main line. Advances up to 1,000 ft can be made without moving out of the place and without any other operations than adding stands and belt. Sections of belt and stands 100 ft long, permitting advances of 50 ft, usually are added in less than 5 min. Plans for taking pillars with extensible belts are included with other plans in the "Development," "Continuous Min-



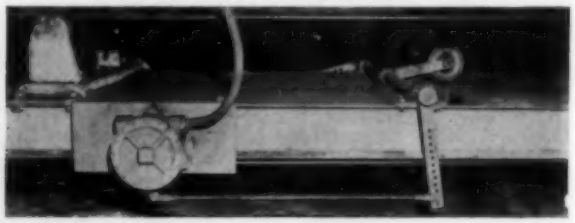
TRIP-LOADING PLAN illustrated above involves circle tracks around the beltheads, permitting locomotives to move trips continuously without storing empties. The loop is completed at the slope bottom.

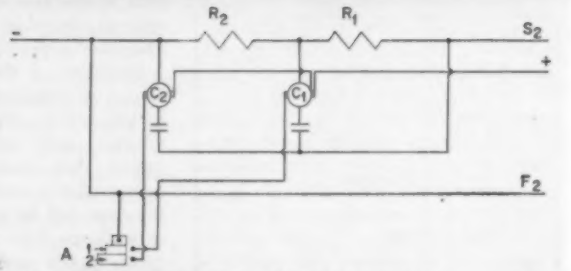


SIMPLEST TRIP LOADING is tail track, turned 90 deg through crosscut, as shown in this plan.

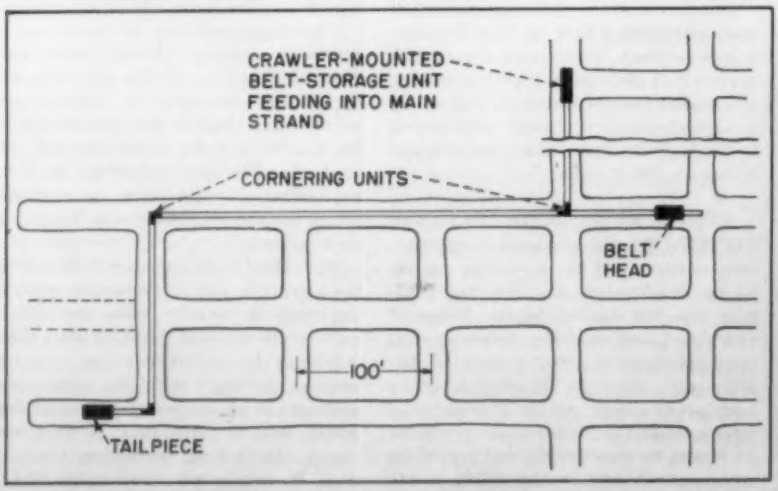


ALL-ELECTRIC AUTOMATIC loading point provides unattended trouble-free car loading. Steel swing flaps in hood control spotter operation as coal builds up.





PREVENTION ON BELT OVERLOADING is accomplished in this system by load-sensing wheel and electric control circuit (*Coal Age*, December, 1958, p 144).



CORNERING BELT PLAN provides for crawler-mounted belt-storage unit for additional flexibility and fewer stops for extensions. Groups of places may be developed without moving the drive and transfer point.

CORNERING DEVICE permits 90-deg turns in belt conveyor to keep continuous transportation close to face machines.

ing" and "Mechanical Mining Planbooks" elsewhere in this Guidebook.

THE CORNERING BELT—A new coal-company development permitting a belt conveyor to be turned 90 deg without breaking the belt and setting up an auxiliary drive increases the flexibility of the extensible unit and permits development of groups of places without moving the drive and transfer point.

The cornering or right-angle-turn device also makes possible a system of development eliminating a number of the stoppages and time and labor involved in even the relatively few interruptions with the conventional extensible unit. As shown in the accompanying diagram, this is accomplished by means of a crawler-mounted storage section in a heading in advance of the opening in which the main belt section is placed. When the usual length of extension represented in the belt stored on the drums is exhausted, the entire crawler unit is trammed forward or backward as necessary to permit a new advance with no further operation.

Trip Loading

Trip Movers

Various systems and units for moving trips past loading stations, whether they be ramps, elevators, belt discharges, or what have you, include the following among others now used:

1. **Gravity**—Possible but hazardous with the usual spragging.

2. **Gravity Retarding**—Feasible with a rope and a brake drum with manually or motor-applied brake.

3. **Operator-Controlled Locomotive**—Fairly widely employed in the past and still employed in a number of mines. Ordinarily means an extra labor cost unless the same motorman pulls to sidetrack or outside in which case care must be taken to see that the trip-changing interval is not too great. Complete looping of track, discussed more fully later in this section, facilitates this trip-moving scheme.

4. **Remotely Controlled Locomotive**—Machine with brake set up as required and with the controller on the first point, on separate section of wire which is energized to move locomotive and trip by switch operated by boomman or attendant.

5. **Remotely Controlled Trip-Spotting Hoist** — Sometimes accompanied by smaller hoist to pull rope back for coupling to fresh trip.

6. **Barney, Chain-Feeder and Ram-Type Between-the-Rails Spotters**—Newest in the line of trip-moving equipment, these units are positive and accurate in operation and permit designing transfer stations for maximum efficiency in trip changing. The changing function can be preset or controlled by limit switches for precision and also for automatic performance if desired. Also such equipment lends itself to operation by shuttle-car drivers, and thus, even if not made automatic, requires no special attendants.

Track Layouts

The simplest form of track layout for car or trip loading is the tail-track system. The track can merely be extended down the heading, or it can be turned right or left, as shown in an accompanying plan, or it may be turned right or left and then turned back U-fashion in an adjacent heading. The major disadvantage is that trips must come out the same way they go in, meaning increased loss of time unless the changing track is very close.

Sidetrack or loop-track systems (see accompanying plan and also the "Development," "Continuous Mining" and "Mechanical Mining Planbooks") provide access from both ends, and thus permit the quickest-possible trip changes, with no time loss at all if properly set up. The sidetrack—if that is the system—may be in the same heading as the main track. More usually, however, it is in an adjacent heading. Or the sidetrack may, in effect, be made continuous by tracking the second heading and installing chutes and crossovers at intervals. Double tracking represents some extra expense but does result in greater flexibility and quicker trip changes.

Automatic Loading

Complete loading of trips without any operators or attendants whatever already has been achieved in coal mining. Now, the number of such installations is increasing at a fairly rapid pace. Late-type underground stations include facilities for automatically diverting the coal from one car to another, controlling the hoist moving the trip, and starting and stopping the belts. Even cars off the track are provided for.

Switching Coal

The problem of switching coal flow one car to the next in continuous trip loading can be met in a number of ways. One is the overlapping mine car or articulated trip in which facilities to bridge the gap are built onto the cars.

Where the coal flow is not too great, means of preventing spillage during car change include a simple plate or chute to catch coal during the change.

Heavier flows of coal, as off a mother belt, usually require power or some other type of equipment for a quick change. Power equipment includes the short reversible conveyor mounted transversely under the head of the main belt. Equipment without power includes a "pants chute" with flop gate to divert the coal stream from one car to the next.

Main Haulage

Rail

ONE-STAGE OR MULTISTAGE?—Main haulage usually is in two stages, relay and main-line, with a few operations dividing it into relay, secondary and main. There is a disposition, however, to question whether multistage operation should be adopted automatically. One-stage operation requires heavy track to the belt head or other loading station, but the extra cost may be much more than offset by decreased haulage labor and maintenance costs.

CARS AND LOCOMOTIVES—Even though cars are less and less taken to the face, where size has an appreciable effect on loading-machine productivity, capacity still is an important factor even in main-line service. One argument for the biggest possible car is that it costs relatively less to buy big cars than small cars. A second is that the big car holds more coal per pound of car weight, and therefore less dead metal has to be dragged around for the same coal. For reference to savings possible with big cars and locomotives see the accompanying "Field Reports" list.

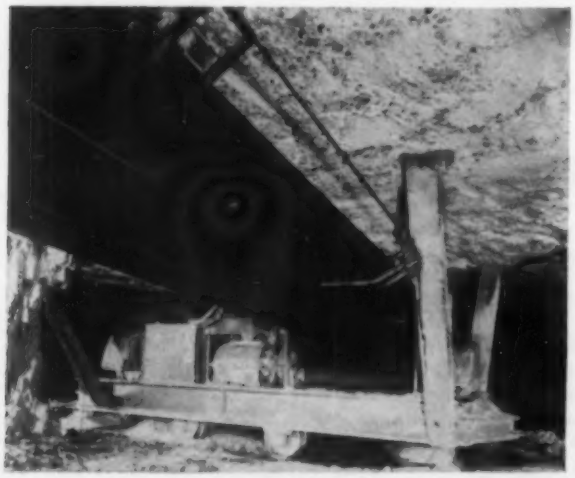
In the case of locomotives, if one big one can replace two smaller ones, there is an obvious saving in labor. Or two smaller units can be made into a tandem job to get the same saving. In at least one instance also, three small machines were tripled into a single 12-mph unit with spectacular savings.

Aids to safety, efficient operation and low maintenance in car design include:

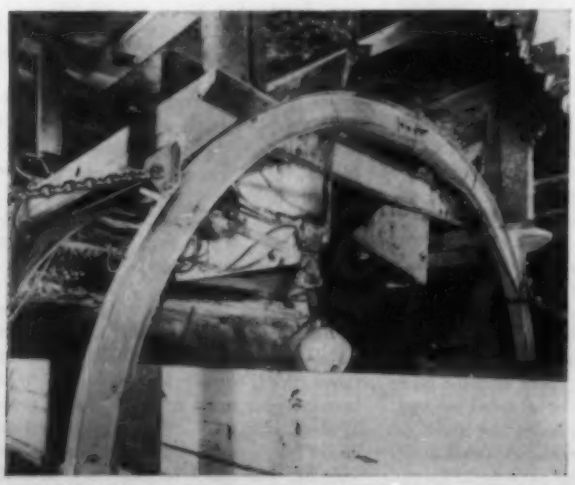
1. **Automatic couplers.**
2. **Spring draft and buffing gear.**
3. **Antifriction—bearing wheels.** With high speeds and swivel trucks, as in 8-wheel design, wheel metal and treatment becomes a more critical problem. Answers include special mixtures and chilling with cast iron, and cast or forged steel.
4. **Lightweight corrosion-resisting materials.** Newest is aluminum plate, shapes and extrusions for maximum weight reduction. Another form of construction for simplicity and strength with minimum weight is the use of standard structural shapes—for example, channels for sides and ends on low-vein cars.

Antifriction bearings also mark the modern locomotive, which, especially in main-line service, tends toward a higher rated speed, usually 12 to 15 mph, with certain types rated up to 35 to 40 mph. Modern electrical controls include provision for dynamic braking where grades warrant. For absolute reliability in such braking, a 32-V battery permits continued operation even when trolley power fails.

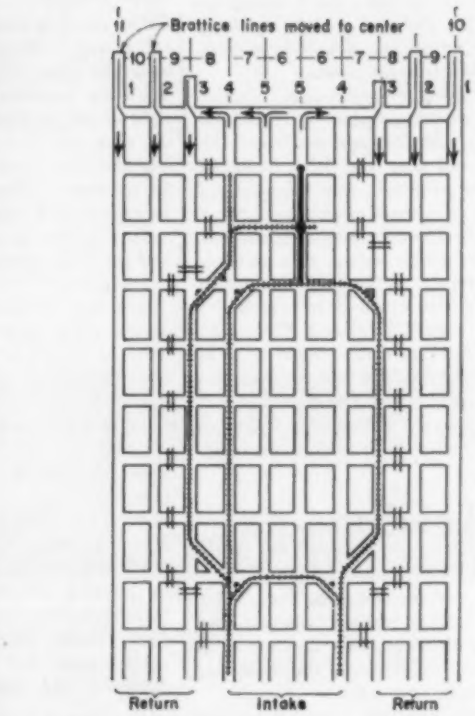
PORTABLE-HEAD CONVEYOR discharges at left into mine cars where automatic loading controls swing flopgate to prevent spillage between cars. Drive is out of picture at right.

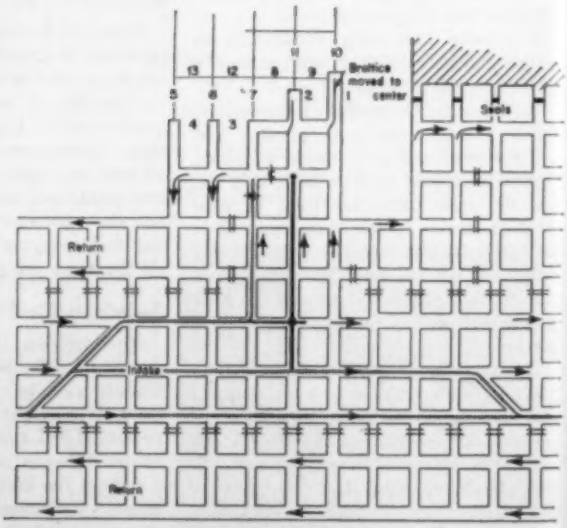


DRIVE UNIT of new belt operates from truck which is anchored in position in tracked crosscut. Unit can be moved in 4 manshifts.



ARCH UNIT, straddling main line track, supports discharge pulley, flopgate chute and other equipment of portable-head conveyor belt for coal-mine application.





TRACK AND MINING PLANS for portable-head conveyor show how spur is provided for mounted drive. Plans also illustrate shuttle-car haulage without going through curtains.

Better Track For Better Haulage

GENERALLY ACCEPTED STANDARDS for good main-line track include 70- to 90-lb rail on heavy treated ties laid in crushed slag, gravel or cinder ballast. The importance of treated ties is shown by one study indicating total tie costs for 1 mi of track for 20 yr as follows: treated ties, $10,600; untreated ties, $34,000.

Welding has come sharply to the fore as a means of joining rails, with steel arc the most widely employed. Curves should have a radius of 300 to 500 ft and should be superelevated. Turnouts should not be less than Nos. 5 to 8. Trolley wire should be hung at a uniform height above the rail and aligned with it at the proper distance outside. Shoe-type collectors should be used where feasible, especially on heavy-duty locomotives, and the trolley wire should be adequately lubricated at the proper time intervals for low maintenance and efficient current collection.

Throws and switch-position indicators are essential for safe, smooth main-line haulage, while alloy frogs and proper guarding keep down maintenance and reduce derailments. Automatic switch-throwers and remotely actuated derails save labor and promote safety.

DOUBLE TRACK OR SINGLE?—Most authorities agree that double track is for the big mines, though they split on what is "big." Advantages of double tracking include complete separation and no interference between empty and loaded haulage. Also, since waiting at sidetracks and passing tracks is eliminated, fewer cars and locomotives are required. Furthermore, one track usually always is available and therefore production seldom if ever is completely interrupted. In addition, some mining men point out, double tracking where grades are heavy makes it unnecessary to use a tail locomotive, which might otherwise be considered desirable. Also, it permits installing spring-type derails on upgrades.

Almost the equivalent of double tracking can be attained by proper location of properly designed passing tracks.

Use of locomotives on both ends of trips may have an advantage other than safety. At one mine this practice also makes it unnecessary to run locomotives around trips, either at the panels or at the main dump (drop-bottom cars). Sections are equipped with looped loading tracks and hydraulic car spotters. The haulage crews, one for each of the two locomotives, change trips at the loading points.

DRAINAGE—Mud and water can reduce the capacity of a haulage system as much as one-third or more. Proper ditching is a major answer to keeping haulage roads dry. If gravity disposal is impossible, sumps should be constructed to receive the water and facilitate disposal by pumping. The importance certain mines ascribe to dry haulage roads is attested by a program of building cisterns in crosscuts at strategic points and equipping these with automatically controlled pumps discharging to an outside line.

GRADING—Eliminating humps and hollows not only makes for smoother, safer haulage but also can result in a significant saving in number of locomotives and crews necessary for a given tonnage. If possible, sustained grades against the loads of over 1¼ or 1½% should be avoided. If averages higher than that cannot be avoided, then it is even more essential to knock off peaks.

TRACK CLEANING—Smoother, faster haulage, less track deterioration and greater safety are the major reasons for emphasis on clean track. Track-cleaning machines naturally reduce the cost to a minimum, while cars in good condition reduce spillage and stretch out the intervals between cleaning. In many instances, a considerable tonnage of good coal is reclaimed in the cleaning process, which might well be credited against cleaning cost. Some mines, as a matter of fact, figure they are well ahead of the game by salvaging coal off the track.

LIGHTING—Safety, speed of operation and maintenance all are facilitated by good lighting of haulage roads. The latest types of units are fluorescent tubes, which provide a significant increase in light output for the same current. For a discussion of fluorescent lighting in working sections, and of incandescent lighting along haulage roads, see *Coal Age*, February, 1956, p 84.

Incandescent lamps were the original light source, with the usual spacing as 75 to 100 ft. With the usual wattage of lamps, this normally is sufficient to comply with the rule that there should be no dark spots between lamps. Glare elimination requires proper location, and if necessary, shielding. Mounting lamps along one rib, rather than in the center, may help in glare reduction.

Haulage Control

Except where the haulage system is of the simplest type, the dispatcher is essential not only for efficiency in haulage but also as a means of keeping a finger on conditions and progress throughout the operation for the benefit of the foreman and superintendent. In his business, he uses not only the regular telephone but, along with other mine personnel, the carrier-current phone—on locomotives and cages as well as in offices and stationary communication posts throughout the mine.

Ready communication with locomotive operators is the great advantage of the carrier-current instrument, the use of which some mine managers have stated has raised output and efficiency 10% or more.

Block signals at times can take over in part or completely in control of haulage, aside from their other major function of preventing interference and collisions. Normally, however, in the control area, they supplement and round out the dispatching program, making it, in the experience of many mines, more accurate and efficient.

Belt Haulage

ROPEFRAME CONVEYORS—Reducing the weight, bulk and complications of the conveyor structure has of course been the the goal of the designer since the first belt conveyor went into service. The need is specially great in the thinner coal where the belt has some added advantages.

Conveyor sections have been progressively lightened and redesigned for quick assembly and disassembly. The use of a wire rope as the carrying member for the top-strand idlers is the latest step toward simplification and reduction of weight and bulk. In addition to a greatly reduced first cost the advantages include a major saving in installation time even thought the same care is taken—as it should be—with alignment and other installation requirements.

Special low-type units have been designed as part of the evolution of the rope belt. Contemplated applications include surface as well as underground and, among other things, the suspension of rope belts over long spans is being studied to add to its versatility.

PORTABLE BELT HEADS—A new development with the ropeframe conveyor is the portable belt head. The first such unit was designed for 2,000-ft-long 36-in mother units specifically designed to receive coal from shuttle cars and dis-

charge into large mine cars. The basic elements are common to most conveyors but the arrangement makes the difference.

The drive section, including motor, controller and power-transmission facilities, is mounted as a complete unit on a rail truck. To move it into position, it is trammed to a spot in the first crosscut inby the main line, which means that the drive is 60 to 100 ft from the belt discharge. The drive stays on the truck, which is anchored in place while remaining on the rail.

The discharge pulley, together with a flopgate chute, are integral parts of a knockdown arch unit which is set up to straddle the mainline track. The arch, flopgate chute and pulley assembly are hauled to the site on a mine car. The arch then is set up and the two-way chute and pulley mounted in place.

Wire ropes are then attached to the arch and are strung out along the entry, passing over the drive. Two or three adjustable supports are used to hold the rope between the discharge and the drive. The remainder of the conveyor is the standard ropeframe unit.

One move involved shifting the entire 2,000-ft-long unit from one entry to another and setting it up ready for use. Total labor required was less than 4 manshifts. In contrast, the usual requirements for the conventional rope unit is 30 manshifts or more.

Belt Operation

One secret of efficiency in mainline belt haulage is proper installation according to the recommendations of the conveyor and belt manufacturers. Another is the employment of one man properly trained and equipped to patrol service and lubricate each 1½ to 2 mi of belt line. A third is proper loading of the belt. Chutes should turn the coal in the direction of the belt, lay down a cushion of fines and, if possible, put the coal on the belt at the same speed. In a few high-tonnage systems, short speedup belts are used to turn coal from panel belts and deposit it on the main-line units in the right direction and at the right speed. Thus, the punishment is largely confined to the speedup unit. Big lumps, incidentally, require a wider belt, a heavier carcass and proper covers. Cushion idlers at transfer points are essential in helping protect the belts. Good splicing is a must.

The most effective method of determining motor and/or belt overloading, particularly with panel belts, is reading the motor current with a tongtype or other meter. Stuck idlers, piled up loose coal rubbing on the belt, and belt rubbing against the frame are common causes of motor overloading. Another, in addition to piling on too much coal, is too much belt for the grades.

FIRE PROTECTION—In addition to the already-accepted methods (*Coal Age*, March, 1958, p 122) the first line of defense against belt fires today is use of fire-resistant cover and impregnating materials. Those employed in belts approved by the USBM are two:

1. Neoprene.
2. Polyvinyl chloride (PVC).

Neoprene already has found substantial use and PVC is coming into the picture, particularly in the form of the "plyless" belt. In other words, a single woven carcass of the desired thickness is employed. It is impregnated with the plastic and the covers applied in the same operation. Covers are the same thickness on both sides and either may be used as the carrying side. One of the first users reports not only practically complete resistance to ignition but also high resistance to cutting, gouging, edge wear, tearing out of splices and other mechanical damage.

An additional advantage of the fire-resistant belt is elimination of the need for a neutral-air opening or a separate split, thus approximately halving the number of stoppings required in a beltway.

ELECTRICAL PROTECTION—Suggestions for electrical control and protection include:

1. Connecting each drive to the line through a stepped resistance.
2. Sequence starting, outby drive first, with proper time delay for each subsequent drive.
3. Automatic stopping of all inby conveyors or elevators if any belt should stop for any reason. The usual device is a centrifugal switch.
4. Interlocking conveyors or elevators feeding to a belt to prevent feeding onto one already full loaded. Devices include finger- or paddle-actuated switches, as well as the wheel-actuated devices described elsewhere in this section.
5. Providing overload or pileup protection at belt transfers, using paddles or other devices to actuate switches and shut down the inby drive. These switches should be of the momentary-contact-type so that the inby conveyor will start again when the overload is cleared.
6. Providing a means of stopping the conveyor anywhere along its length to permit the beltman or any man riding to stop the belt at any time. Continuous pullcord-type controls fastened to the roof also provide protection against falls.
7. Providing drive-pulley slippage control to stop the unit as soon as slippage occurs. A centrifugal switch with pulley riding on the belt, or a centrifugal switch driven by a chain from the bend or snub pulley are two possible devices. A third is a differential control with two pulleys, one riding the belt and the other the drive pulley so that when one gets out of step the drive is stopped.

BELT CLEANING—A number of devices, each more or less satisfactory, have been developed for cleaning belts before they go onto the return idlers. One is a length of piano wire mounted under the head pulley and almost touching the belt (*Coal Age*, November, 1952, p 89). A recent development is a spring-tensioned rubber blade (*Coal Age*, January, 1959, p 127).

DETECTING BELT TEARS—One of the few practicable methods of detecting major tears in operating belts has been developed at a middle western mine (*Coal Age*, January, 1956, p 88). It consists of a horizontal rod 2 in in front of the head pulley. When struck by a torn flap thrown out from the belt by centrifugal force, the rod is knocked down to open an electrical switch and stop the belt until it receives attention.

Hoisting

IN THE ABSENCE of special circumstances, the belt slope is the usual coal hoisting facility installed today. Low operating labor and low maintenance are the major reasons, while improvements in belt design, including rayon, nylon and steel-cord tension elements, have made it possible to install single belt runs up to 3,000 ft or more in hoisting, thus raising the vertical lift to more than 800 ft.

A recent addition to belts for hoisting on the North American continent is the cable belt (*Coal Age*, September, 1958, p 106). This initial installation is providing the expected advantages, including lower operating and maintenance costs.

Belts also work equally well in lowering coal where the terrain permits their installation at inclinations of under approximately 20 deg. Other facilities for lowering include monitors and rope-and-button conveyors and so on.

FEEDING TO BELTS—Any of the standard types of dumps may be employed in transferring coal from mine cars to the belt, unless bottom-dump cars are employed. If so a necessary intermediary is a hopper or bin. Where belts are used for main-line haulage, boomed shuttle belts are used to lay the coal down in a longer and therefore larger-capacity bin. Short transfer and speedup belts also are used between hoppers and slope belts to take the shock and protect the slope unit from some of the wear and tear. Magnetic tramp-iron-detection equipment on either the speedup or main slope belt stops the equipment and permits removal of metal that might result in damage.

Shaft Hoisting

The skip hoist usually raises the equivalent of 2 or 3 cars each trip and thus normally can operate more slowly, with lower acceleration peaks. Where self-dumping cages are employed, fabricating them of high-strength alloys or aluminum reduces dead weight and consequently improves the hoisting operation.

As with all other mining operations, economy in hoisting is a matter of equipment and controls to conserve manpower. Now, any type of vertical hoist-skip, self-dumping or overturning cage, and platform—can be made completely automatic, including caging and, with platform equipment, decaging. Even if complete automatic operation is not desired, automatic cagers, tripmakers and the like speed up the hoisting process and save labor.

MAN-CARRYING BELT is latest device to save exertion and time and handling men on slopes.

Handling Men

PROPER PORTAL LOCATION or relocation provides, among other things, an opportunity for streamlining the handling of men and also attaining maximum convenience and comfort in changing in and out. A collateral benefit is an up-to-date field supply setup, with possibly also a field maintenance shop that is much nearer the active workings.

KEY OBJECTIVES—Aside from supplies and maintenance, key objectives in portal design include:

Ample all-weather parking.

Good wash and change facilities.

Good lamphandling facilities.

Protected facilities for men waiting to board trips—from weather and electricity particularly.

Adequate first-aid facilities.

Hoisting

Where men are handled through separate man-and-material shafts, either at the main opening or back at field portals, usual practice today is to install pushbutton-operated elevator-type equipment in capacities up to 50 men, which reduces the total time required to put a crew into the mine car or bring it out. The cage may also be adapted to handling heavy supply items, though the tendency is to use the regular opening for this purpose, especially drift or slope.

Drilled shafts with automatic hoists may provide a lower-cost answer to the problem of putting portals close to the working areas. At one mine (*Coal Age*, November, 1955, p 60) a 72-in drilled shaft was fitted with a double-deck circular cage with a capacity of 10 men per deck. Pushbuttons control the automatic hoist. Hoisting distance is 487 ft. Travel time was cut 45 min with a resultant rise in output.

SLOPE CARS—Where men enter through slopes, some mines, where the regular equipment cannot be employed, provide special slope cars for that part of the trip. If single cars are employed, the trend today is to equip them with magnetic track brakes actuated by an overspeed device or by a pushbutton under the control of a foreman or trip-rider. Where several cars are put together in a trip, they can be preceded by a pilot car with magnetic-brake equipment. If men walk the slope, a "ski-tow" installation, which gives them a one-handed pull, is a major help in negotiating stairs in the "up" direction.

Car Transportation

Where height is sufficient, the covered mantrip car is practically standard for transporting men by rail. In addition to cars pulled by locomotives self-powered units are available in capacities up to full section crews, making it unnecessary to detach locomotives for this service.Where several individual cars are in service, dispatching and block signals are essential to prevent collisions. At trackless mines, corresponding equipment on rubber, battery-powered, is available.

Low coal makes it more difficult to cover cars that go into areas where top is not taken. Flat-bed rail cars with rubber mats can be used, with the men lying crossways. Self-propelled types include one in which the men lie down with knees up to each end (*Coal Age*, March, 1954, p 190). Capacity is sufficient for a section crew of 11 men. Height over the rails is 24 in. As in thick coal, equivalent equipment is available on rubber for thin-coal operations.

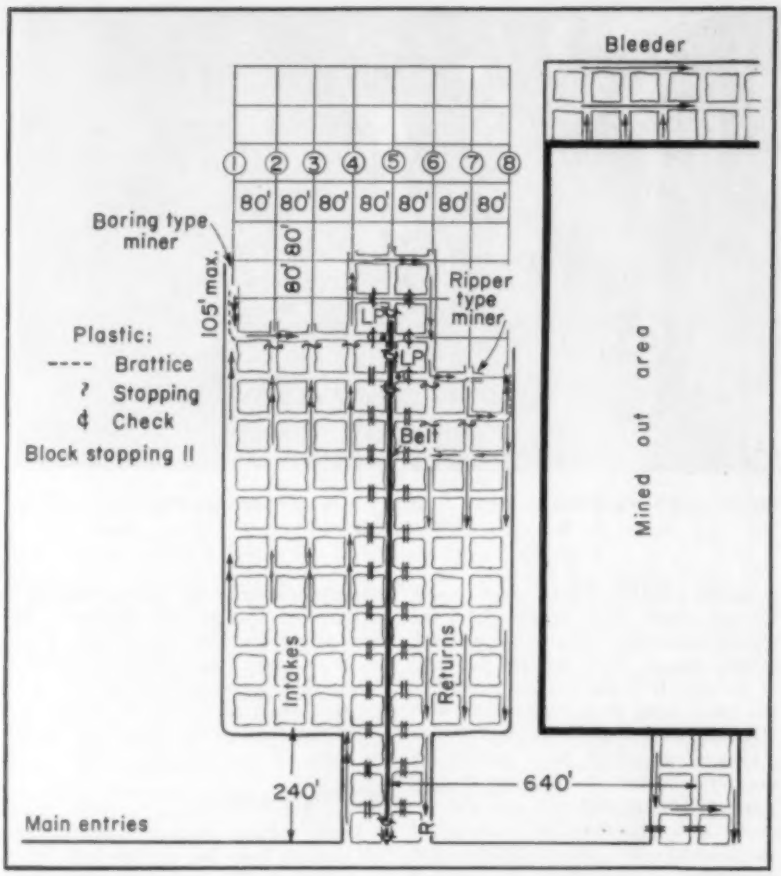
In addition to regular mantrip cars, a variety of rail and rubber-mounted cars may be employed to save time and promote efficiency in transporting mechanics, electricians and repairmen, as well as officials. The list includes even small one-man three-wheeled "trikes" for trackless operations. Types for mechanics, electricians and repairmen include tool and supply boxes and wells or decks for carrying heavy items.

Belt Transportation

Under proper safeguards, movement of men on belts has proved both safe and efficient. The major safeguards include ample vertical clearance all the way, extra clearance at points where men get on and especially where they get off, equipment to reduce speed to approximately 200 to 250 fpm, and an emergency stop cord or stop system all along the belt so that any man can stop it at any time. The system should be designed so that the belt cannot be restarted without a check to see that no hazzard is involved. A space of a least 6 ft must be maintained between each man on a belt.

Belts may be reversed to take men in, and a few mines have designed mainline systems with that in view. In going in, men necessarily must get off and change if more than one belt is in service. There also should be a rigid rule that men get off and change coming out as well. Ample clearance and smooth unencumbered footing should be provided at all loading and unloading points. Finally, in addition to all other steps, no movement of men on belts should be permitted except while a responsible supervisor is present.

SLOPE BELTS—In addition to level movement special low-speed low-cost belts now are employed in hoisting men up slopes (*Coal Age*, September, 1958, p 130).



MULTIPLE-ENTRY section is advanced and retreated by two continuous miners, including driving bleeder-entry hookup as last phase of development. Line curtains and checks are made of plastic sheeting.

Starting points and follow-through in the design of . . .

Effective Ventilating Systems

What is needed . . .

1 Sufficient air at the immediate face to effectively dilute methane and to serve as an agent in controlling dust
2 Providing this air at lowest possible cost, consistent with safety and utility

How to get what is needed . . .

1 At an existing mine, complete an accurate survey of present ventilating performance; at a new mine, consider later ventilation needs in early planning
2 Select modern fans and air-coursing equipment that can grow with the mine as the need develops
3 Keep a checkrein on costs by pressing for lower power requirements—particularly, preventing fugutive air
4 Take steps to reduce need for regulation, where economically possible
5 For safety reasons, consider bleeder-entry plans, study auxiliary face ventilation possibilities

Where to Find It...

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Reconnoitering ..... p 255
Fans and Supplies ..... p 255
Controlling Costs ..... p 256
Coursing the Air ..... p 257
Ventilating for Safety ..... p 257

VENTILATING A MINE is somewhat analogous to the pumping of liquids. In both cases, a pressure system is involved, employing (1) a power-consuming device somewhere in the circuit to create a pressure differential, (2) closed conduit to carry the pressurized fluid and (3) a discharge to the atmosphere. Safe, economical ventilation consists of taking maximum advantage of the pressure differential to scour all active openings with fresh air, then to reject the refuse of the process through the return airways into the atmosphere, avoiding the use of excessive power to project the discharge stream into the atmosphere.

Achieving maximum advantage of the pressure differential is the core of the ventilation engineer's job. It is also a prime job requirement of all legally certified mine officials. Stripped to its essentials, the job of ventilating a coal mine involves the following:

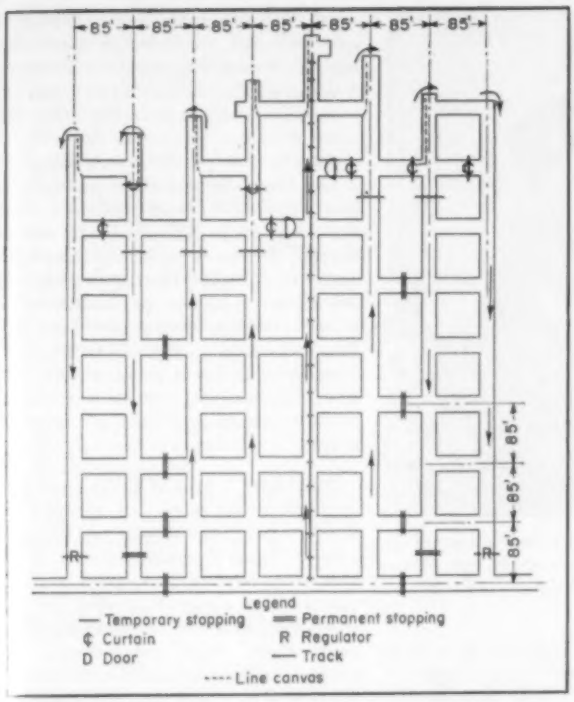
1. Employ an efficient fan that will provide a pressure difference of such magnitude that the desired quantity of air will flow against the resistance offered by the airways.

2. Keep this resistance to a minimum —by providing sufficient airway area— to minimize the amount of power required at the fan to create the pressure difference.

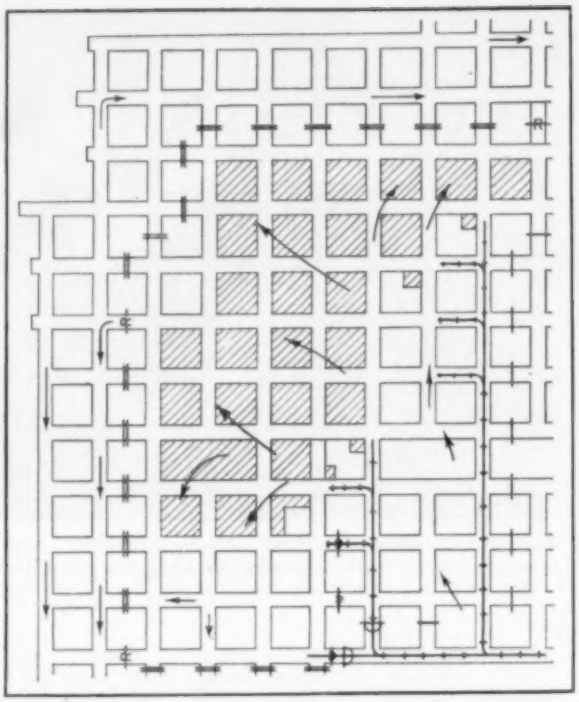
3. Split the air current to insure safer ventilation of individual areas of the mine.

4. Introduce regulation as needed in the low-resistance splits to balance the system.

Coursing the air within the splits requires strict supervision and iron-clad discipline, especially in continuous-mining sections. Furthermore, a management decision will have to be made as to whether worked-out areas are to be sealed or ventilated. A decision to ventilate these areas means that a system



TWO-SPLIT section ventilation, with four center headings as intakes and four outer headings as returns, provides up to 35,000 cfm in immediate face areas. Cinder-block permanent stoppings are erected as development proceeds.



REGULATORS in active pillar section cause air to flow across pillar line. Line brattice can be added to increase flow along pillar line. Bleeder openings are examined daily by certified officials as an added control feature.

of bleeder openings must be designed. Then the entire circuit must be patrolled and maintained because a coal-mine ventilation system grows longer and more complex every working day.

The Fundamentals

Most of the effort in designing or updating ventilation systems is put forth with one eye on the power bill, since the goal is to provide adequate ventilation at minimum power. And following back from the power bill, it is seen that keeping the velocity of the air within reasonable limits is a basic requirement because (1) power varies as the cube of the velocity; (2) pressure varies as the square of the velocity, and (3) quantity varies directly with velocity.

Improvements in varying degree may be achieved by cleaning up airways to reduce resistance, sealing leakage, splitting and regulating in the most efficient manner, shortening the distance of air travel through the use of new airshafts and other such steps.

Even at mines where the ventilating duty is governed by the amount of methane made in the workings and the necessity of diluting it and sweeping it away, there is the possibility of draining off some of the methane through boreholes tapping the solid coal ahead of the mining.

Reconnoitering

When the job at hand consists of planning a ventilation system for a new mine, the officials in charge of the work should avail themselves of all information and experience offered by others who have conducted operations in the same seam or area. Helpful leads and precautions will be brought to light that will result in the highest degree of modernization in the equipment and plans for ventilating the new property.

This search for available experience and information is particularly important if the new mine is to employ continuous-mining methods. Steps can be taken from the day ground is broken to insure that sufficient air is made available to working sections to effectively serve continuous-mining faces. This is one aspect of reconnoitering the situation in approaching a ventilation problem.

More often, however, the engineer or mine official is required to improve an existing system in order to reduce costs or increase ventilating efficiency at the face. The first order of business in modernizing an existing layout should be the completion of an accurate velocity-pressure survey. This reconnaissance will identify regions of high resistance or excessive velocity and will help determine the extent of wasteful leakage and the locations of leaky control devices.

Some companies have found it advantageous to feed data from ventilation surveys to electric-analog network analyzers to get a picture of air-flow distribution without pursuing laborious calculations. The Bureau of Mines operates one of these units.

Fans and Supplies

Modern fans, with few alterations in mine conditions, often can effect substantial reductions in power consumption, partly because of the inherently higher efficiency of the new units and partly because the new fans can be more closely matched to mine characteristics. Quick blade adjustment makes it relatively easy to keep mine and fan more closely paired.

Better design in ventilating materials is not confined to fans alone. Also available are improved curtain materials, including treated cloth and neoprene-coated types. The latest item in this line is a plastic check curtain with a transparent center panel to aid shuttle-car operators.

REUSABLE MATERIALS—New materials for stoppings include telescoping metal sections and sheet plywood. Noteworthy features in these are rapid installation for savings in labor and full reclamation for savings in supply costs.

FAN MONITORING SYSTEMS are essential where main fans are operating at remote points, and especially at mines employing more than one main fan. Maintenance of the monitoring system should be entrusted only to trained men.

Not to be overlooked in the list of reusable materials are cinder blocks. However, there are vast differences in the permeability of cinder block, both among the products of different manufacturers and among the lots of the same manufacturer. Giving more attention to specifications in the purchase of blocks and to testing the blocks upon delivery will result in reduced leakage through stoppings.

Prefabricated materials, corrugated pipe sections for example, may be used to construct air bridges, thus cutting the cost of such construction and permitting the use of more overcasts to the exclusion of doors and other wasteful air-current controls. As a result of these developments, overcast is no longer a bad word in ventilation.

The main point to remember in constructing overcasts is that causing the air to pass through abrupt changes in direction or area results in excessive losses in useful ventilating pressure due to turbulence and shock. The cross-sectional area of the overcast may be less than that of the approach without resulting in appreciable losses, if the approach is gradually narrowed down to the area of the overcast. The object is to simulate, as near as possible, a true venturi section.

AUXILIARIES—Auxiliary air movers, including fans and portable evase units for the control of compressed air, may be of some help when properly used with the approval of regulatory agencies. Better ventilation in continuous mining has been achieved through the use of auxiliary exhaust fans and flexible tubing. Installed with safeguards against recirculation, the fan provides adequate air at a velocity which is sufficient to remove dusts to an appreciable degree, improve visibility at the face and dissipate the heat generated by the face equipment. Improvement of these fans is a matter now receiving intensive study in the industry.

At least one installation of an inertial, wet-type dust collector has been made on a boring type miner to perform the combined duty of passing air across the immediate face and precipitating dust. Others are seeking practical ways to mount auxiliary blowers, exhausters or diffusers directly on the mining machines in order to provide a source of air that moves up as the miner advances.

In anthracite, trumpet-shaped air movers, connected to compressed-air lines, have been used to direct air to the faces of steeply-pitching places beyond the last open cross-heading.

Doors are a necessity at some point in every system. Recent developments in these include a compressed-air-powered automatic door for heavily-travelled haulageways. The operating controls are actuated through the trolly system and all mechanical linkage and the operating cylinder are suspended from the mine roof and attached to the top of the door. None of the parts is exposed to wet bottom conditions nor to damage from possible derailments. Some mines now swing their conventional doors from steel jacks to make possible faster relocations.

Controlling Costs

The advantages to be found in modern ventilating equipment may be fully realized or they may remain undeveloped, depending upon the degree of care and skill employed in conducting the air through the workings. Excessive leakage and insufficient airway area are especially wasteful, no matter how efficient the fan.

Fugitive air is the most expensive luxury in today's coal mines—and the most dispensable. Surveys of some mines show that up to 80% of the air moving through the fan never reaches the working faces. It leaks through poor stoppings, around doors and so on, back into the returns without moving anywhere near the active sections. Even in mines where ventilation is given more serious consideration leakage may short-circuit up to 30% and more of the incoming air supply.

PREVENT LEAKAGE—The penalties in fugitive air, measured in terms of wasted power, are shocking in some instances. Since a certain quantity at the face is mandatory, fan speed must be increased to insure that effective face ventilation, over and above leakage, will meet these legal requirements. And power consumption increases as the cube, while the increased velocity contributes to still more leakage.

Sealing at points of excessive leakage is one way to lick the problem. As previously mentioned, cinder blocks differ in permeability, and it has been found that cinder-block stoppings can be made more airtight by applying a coat of plaster. A coat of paint over the plaster provides a still tighter seal. One company has sealed hundreds of stoppings by mixing portland cement with the slurry in a wet rockduster, then applying the mixture to the stoppings in the conventional manner of wet rockdusting.

Another way to reduce leakage is to look for ways to achieve one-way flow, thus eliminating leakage opportunities by doing away with side-by-side intakes and returns separated by porous stoppings and other leaky control devices. Airshafts or openings to the outcrop may be used as new fan locations or additional intake openings to get the one-way flow. Even in deep cover, the cost of a new shaft may be more than recovered in a reasonable time in power savings alone.

Furthermore, the cost of sinking a shaft is not what it used to be. In one instance (*Coal Age*, June, 1958, p 106), a shaft was sunk by drilling a circle of large-diameter holes with an overburden drill, then shooting the hard core against the relief provided by the drillholes. The job was quickly done with fewer men and in greater safety.

In another instance (*Coal Age*, November, 1955, p 60), a shaft was sunk using a core drill which cuts a 75-in hole at rates of 4 ft per hr in limestone and 1 ft per hr in sandstone.

In another area where numerous wants and faults occur, it is found that a pressure system is best in ventilating long narrow gassy areas of coal so long as bleeder shafts are provided at the extremities of these coal areas. As soon as the limits of these areas are determined by completion of development work, a bleeder shaft is drilled down to the coal to remove the gas-laden air from the pillaring sections. Loose ground through which the bleeder shaft is to be drilled is consolidated by grouting. Then a 36- to 48-in hole is calyx-drilled to make the bleeder shaft.

One-way travel contributes to even bigger power savings inasmuch as a change to this system results in increased airway area with former returns now serving as intakes. The upshot is either reduced velocity for the same quantity or higher quantity at the same velocity, a bonus either way.

Coursing the Air

Increased safety is by all odds the big reason for splitting air currents underground. An explosion in a mine ventilated by one continuous current of air could affect the entire mine, while in a mine served by several splits the effects would be more confined.

There are other good reasons for splitting. The mine resistance is reduced, power is conserved, and better local control of the air becomes possible.

The ideal situation, which shows all splits naturally balanced in resistance, is seldom achieved in actual practice, since in some splits development work will predominate and, in others, room work. Some regulation becomes necessary to raise the resistance of all other splits to that of the longest or high-resistance split. Up to a point regulation is helpful, but it can become wasteful.

It pays to investigate the possibility of using an auxiliary fan to serve the high-resistance split alone, thus eliminating any need for adding resistance in the other splits. The benefits are reduced power requirements and lower pressure differentials on stoppings outby the booster fan.

Sometimes a well-planned cleanup in the free split may result in the passage of more air, also reducing the need for added regulation in all other splits. Some companies have found a ventilation bonanza by rehabilitating old airways with roofbolt support in place of timbers. The resulting increased area and decreased resistance work together in compounding the benefits.

FACE VENTILATION — Recent studies indicate that getting a sufficient volume of air up to the face crosscut is not the big problem. In continuous mining the big problem is to conduct this available air across the "teeth" of the machine, right at the immediate face. Even a well-constructed line curtain may leak most of the intake air before it comes anywhere near the face. If line curtains are used, their installation must be closely supervised in every instance.

Elimination of doors and checks across shuttle-car roadways is accomplished at one mine by diverting intake air around transfer points in the belt entry. The system is based upon 3-heading entries in room panels, with the panel belt in the center heading. Two well-constructed checks are built across the belt heading on either side of the shuttle-car dumping point and a stopping is erected in th entry breakthrough between these two checks and on the side of the belt opposite the dumping point. Intake air is thus diverted around the dumping point to the outer heading. It returns to the center heading beyond the dumping point.

Ventilating for Safety

Accumulations of gas in worked-out areas are especially hazardous in today's coal mines because of the rapid extraction in highly mechanized methods and the consequent increase in the rate of methane emission. The worked-out area increases rapidly, close by the active places where a number of electric-powered machines are concentrated and the entire crew is assembled.

In conditions like these, more and more operators are including bleeders in their mine projections to ring gob areas with openings through which air passing through the gob may be conducted directly to the returns. In some instances, air from the worked-out areas passes into the returns through regulators which control the quantity of air passing through the gob as well as insuring adequate air and positive pressure along the pillar line. Properly maintained bleeder headings practically eliminate the possibility of gas migration during periods of low atmospheric pressure.

Along similar lines, it is advantageous in gassy conditions to begin recovery of room panels by driving a pair of line rooms along the outby limit of the panels parallel to the mains. Such rooms serve as an extra pair of low-cost airways, and the outby room may be preserved in the bleeder network after the panel has been robbed.

Also in the field of safety are designs for automatic methane detectors which will interrupt line power to electrified face machines when methane content rises to a predetermined value. And more and more mines employing multiple fans are turning to the use of automatic monitoring systems to provide centralized information on fan outages. These systems of fan control are coupled with definite rules for inspection of fan stations when the monitoring system indicates an outage. Self-closing doors associated with each fan in multiple-fan systems prevent reversal of airflow which would further complicate the situation. A wise practice at such mines is to take advantage of idle days and vacation periods to study the changes in distribution of air as each fan is shut down in turn.

Field Reports

Face Ventilation—Steady emission of methane from working faces, continued bleeding from ribs and float dust are major problems in ventilating continuous-mining faces. Depending upon rate of emission, solution to the problem may require auxiliary fans, tubing and brattice lines. *Coal Age*, February, 1959, p 96.

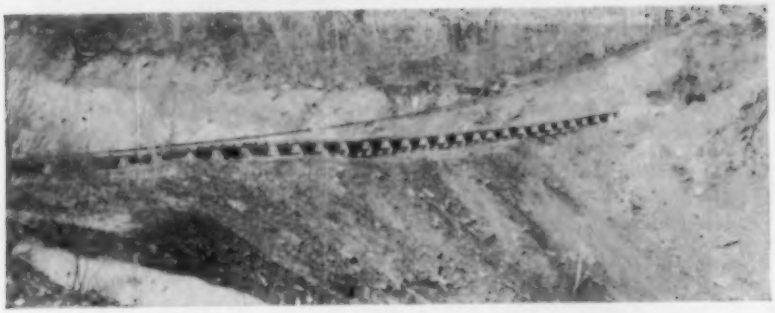
Multiple-Fan Ventilation—Maximum safety in multiple-fan ventilation requires use of self-closing doors, two-split section ventilation and fan-monitoring systems. *Coal Age*, January, 1959, p 96.

Air Distribution—Studies of resulting air distribution after fan stoppages in multiple-fan systems prevent hazardous conditions. *Coal Age*, August, 1958, p 88.

Shaft-Sinking—Blasthole shaft-sinking shows significant cost and safety advantages. *Coal Age*, June, 1958, p 106.

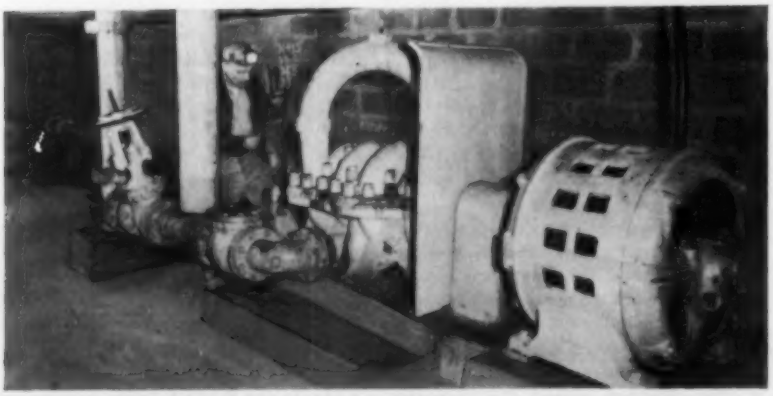
Weather Effects—Passage of fronts may affect methane emissions and mine-moisture conditions. *Coal Age*, February, 1958, p 164.

Bleeder Shafts—Core drilling of large boreholes is most economical way of sinking ventilating shafts in Pocahontas No. 4 seam. *Coal Age*, June, 1957, p 99.



USE FLUMES and ditches to keep water out of workings.

EMPLOY GRAVITY FLOW to minimize power requirements.



SELECT PUMPS and design pipelines for specific conditions.

The Approach

Keep the water out, if possible
Look for gravity-flow opportunities
Then design for low-cost pumping

Achieving Results

Use boreholes to shorten pumping distances or to eliminate pumping altogether
Plans for peak or peakless pumping depend upon cycle of production operations
Use modern labor-saving materials and supplies in constructing mine-drainage pipelines
Take steps to minimize acid discharge and prevent pipeline corrosion

Handling Mine Water

Where to Find It...

Diversion and Gravity Flow . . p 258
Selecting Pumps . . . . . p 259
Planning Pipelines . . . . . p 260
Special Projects . . . . . p 260
Lower-Cost Water Handling . . p 260
Clean Streams and Pipelines . . p 260

DETAILED PLANS for handling water will have to be made at most mines. Procedures for getting the job done, in order of preference, are (1) keep the water out of the mine, (2) return it to the outside by gravity flow if it does get into the workings and (3) design for high-efficiency pumping through the straightest, shortest pipelines it is possible to achieve, using boreholes to the surface or outcrop wherever this opportunity presents itself.

Mine drainage is somewhat like mine ventilation, in this respect:

The most efficient fan in the world cannot provide low-cost ventilation if the airways present high resistance, if excessive leakage is permitted or if expansion of the workings outruns the plans for extending ventilation. Similarly, inherently high efficiency in a pump can be diluted if suction and discharge lines are poorly designed and installed, if excessive labor is required to maintain the lines or if pump operation requires attendance.

However, first order of business in drainage is to keep the water out.

Diversion And Gravity Flow

Diversion ditches around openings, sealed stream beds at troublesome points, grouting underground to seal off stream channels, new channels if necessary and well-constructed dams are possible controls which may be used to keep water out of underground workings. Flumes make it possible to conduct surface water across previous areas of mining properties and dump it back into natural drainage channels on the other side.

It is neither possible nor practicable in most instances to keep out all water. Some provisions must be made for handling underground inflow.

Other things being equal, it may be possible to lay out the mine so that workings advance to the rise, giving an assist to haulage as well as to drainage.

USING BOREHOLES – In other instances, it may be possible to drill boreholes to the cropline or into a sump area to permit gravity flow by the most direct path. At one mine, where some places necessarily are advanced to the dip, 2-in boreholes are drilled at the face through 60 ft bottom rock to old workings in the seam below. The old workings are open to the outcrop, facilitating gravity drainage of both seams.

SUMPS IN DIP WORKINGS–At a new mine, where the seam dips 8%, room panels are worked to the dip from strike entries on advance and up the pitch on retreat. The idea is that the dip workings are finished before extensive areas have been opened up, and the dip rooms will serve as sumps for the uphill workings.

When all's said and done, however, chances are some pumping will have to be done. But handling water with today's equipment is a far cry from the difficult job it was in the past. Today's advantages include efficient pumps for any type of duty, electric power in place of steam, automatic controls to cut the cost of operation and materials designed for long life at reasonable cost.

Selecting Pumps

The type of pump selected depends entirely upon the pumping job to be done. In two out of three of today's mine-drainage applications, centrifugals of one type or another will be found, but each of these is practically a tailor-made unit.

Field Reports

Aluminum Tubing–Rolled grooves at joints permit faster assembly of thin-walled pipelines. *Coal Age*, April, 1958, p 110.

Neutralization–Water-powered device facilitates addition of hydrated lime to run-off stream. *Coal Age*, March, 1958, p 148.

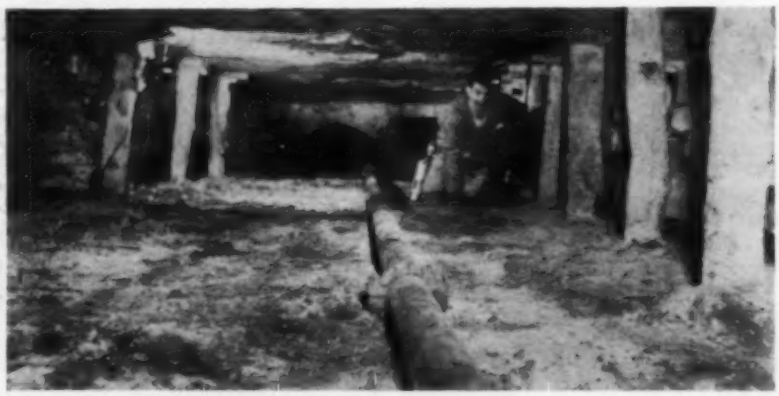
Dual-Purpose Borehole–A 4-in water line is installed in the same borehole with four 2-in pipes for power cables. *Coal Age*, June, 1957, p 70.

Acid Drainage–Demands for clean streams make it necessary for producers to prevent acid formation, insofar as possible. *Coal Age*, June, 1958, p 72.

SPECIFYING THE PUMP – The pumping job at one mine may be entirely different from that of its nearest neighboring mine with regard to such factors as volume, total head and water acidity. The best bet, therefore, is to work closely with a pump manufacturer in determining the one best pump for the application.

The final selection will depend upon whether the service is to be continuous or intermittent, whether AC or DC power is to be used, how much water is to be handled, how much variation may be expected in suction and discharge heads and so on.

SPECIAL CONSIDERATIONS – If the water is free of solids, a multistage centrifugal unit to work against a high head may be used, but if solids are present a number of single-stage units in series should be used because solids ruin multistage pumps. Thus pump selection becomes an exercise in balancing a number of sometimes-conflicting factors. Complete foreknowledge of the conditions is vital to successful selection.



QUICK-COUPLING FITTINGS conserve labor in laying lines.

LIGHTWEIGHT, thin-walled pipe, with special fast connectors permits faster relocation of pipelines.

ACCESSIBLE strainers and check valves in large-diameter lines facilitate pipeline maintenance.

Also important in selection is a decision as to whether the total pumping capacity should be provided in a single unit or in twins, with the latter choice getting the nod in most recent installations because of the resulting flexibility.

Foresight should be used in arranging the pumping schedule to dovetail with operations. For example, at a three-shift mine it may be desirable to provide "peakless" pumping to spread the pumping load over the entire day, while at a two-shift mine it might be better to provide enough capacity to handle all the water on the off shift when demands for production power are at a minimum. In either case, sump capacity will have to be planned and provided to suit the system finally selected.

And in certain special cases, it would be well to investigate the possibility of "community" systems among several mines or companies. These would eliminate the waste of rehandling the same water at one property after another.

Planning Pipelines

Usually the major variable which is amenable to some measure of control is the friction head in the piping itself. The quantity to be pumped is a definite figure and the static head is fairly fixed, but the friction head can be held to a minimum by designing for the largest-diameter, straightest pipeline it is possible to achieve.

Small pipe and numerous fittings and turns will extract a penalty in the form of either higher power requirements or reduced volume of discharge.

In the normal case, pipe of the largest usable diameter will be most economical in the long run.

SYSTEM DESIGN—A well-designed pump installation will show these features:

1. The suction line leads straight into the pump for a length equal to four to six pipe diameters.

2. The suction pipe is one or two sizes larger than the pump nozzle, and it is connected to the pump through an eccentric reducer which is properly placed to eliminate suction-line air pockets.

3. The drive motor and pump are in good alignment.

4. The piping is supported so that the pump carries none of the pipe-line weight.

5. Priming auxiliaries, if they are needed, and lubricating facilities are in good working order.

Priming water for one underground pumping station is taken from the dust-allaying spray water system. An automatic cut-off is provided to disconnect the spray system as soon as the pump takes up its load.

Special Projects

Fitting the pumping system into the overall mining plan is another matter. This is another instance where each set-up is somewhat different from any other, as local conditions dictate. An example of how to get the most out of a dollar of drainage cost is demonstrated at one mine where three gravity-fed sumps and three pumping stations remove 3,000 gpm in three stages over a distance of 3½ mi. Each station is provided with independent pumping power through a borehole cable. Wood pipe in 8-, 10-, 12- and 16-in diameters is used.

The two main pumps at this property operate on alternate 12-hr cycles thus making a peakless pumping load on the power system. The sumps act as accumulators in making this pumping schedule possible.

DEWATERING — At an anthracite mine the problem was to unwater some workings on the other side of a 200-ft barrier pillar to permit recovery of the pillars in the flooded mine. Broken strata above the workings ruled out the possibility of using a borehold to the surface. The solution was to drill a pair of 12-in horizontal holes from the active mine through the barrier pillar to tap the flooded workings. The borehole lines were connected to a 7,000-gpm 700-hp pump which discharged through 2,300 ft of 18-in asbestos-cement pipe installed in the slope of the active mine.

LARGE-DIAMETER BOREHOLES—At another anthracite property it proved to be more advantageous to drill two 24-in boreholes from the surface to a depth of 537 ft to reach the best natural sump in a worked-out lower vein. Upper veins then could be drained into this sump through smaller boreholes which were drilled at intervals as the workings advanced to keep the pipelines to gathering pumps as short as possible The two larger boreholes each serve a 4,400-gpm 10-stage pump, driven by a 700-hp 4,000-V AC motor.

Incidentally, both of these anthracite drilling operations were let out on contract to a company that specializes in these projects.

Lower-Cost Water Handling

The system must now be operated and maintained with minimum expenditure of service labor. This means that pumps and other drainage equipment must give longer trouble-free service, pipelines must last longer, relocations of pumps and piping must be made in less time, and long runs of piping must be installed in the shortest possible time.

Every manufacturer of drainage supplies designs his equipment to perform one or more of these functions. Here are some examples.

Saving Labor in Pumping—Pump controls ranging from simple float switches to elaborate fully-automatic systems for large stations are available. Modern pumps can be made of special alloys or lined with coatings which increase pump life in handling corrosive waters. One anthractie operator found he could increase the interval between overhauls by painting pump interiors with special insulating varnish, normally used in electrical applications.

Longer Pipe Life — Asbestos-cement, plastics, aluminum alloys, synthetic rubber, special coatings—all these materials in the form of mine pipe have materially increased time-in-service for pipelines. A new offering, now on the market, is a line of grooved pipe fittings, in malleable iron or aluminum up to 12-in diameter, which are lined with polyvinyl-chloride.

Faster Relocation—Fast snap action couplings for use with plain-end pipe now permit fast disassembly and reassembly in a new location of pipelines up to 6 in in diameter. Grooving machines now are available for modifying plain-end pipe to take the faster self-aligning couplings.

Quick Installation of Longer Runs — Long coils of lightweight plastic pipe or long sections of aluminum pipe now can be installed by one or two men, where the same men formerly would be hard-pressed to lay a fraction of this length in the same time.

Clean Streams And Pipelines

The pressure on preventing acid mine water and mine-waste solids from entering public waterways is mounting year by year. In designing drainage systems and arriving at pumping schedules, mine operators may have to weight their plans in favor of fast removal of mine water to prevent long contact with sulfuritic materials. In some instances, this may be an overriding consideration in designing for sump and pump capacity.

Faster handling of mine water will also be helpful in delaying the buildup of "yellow boy" in pipelines, and in lessening the corrosive effects of the highly-acid water that would result if the water were allowed to stand in the mine. The end product of this kind of planning will be longer lasting pipelines, which means additional savings in drainage-system labor.

Power Designs For Modern Mining

Design Purpose . . .

An efficient distribution system insuring maximum service and protection of equipment and personnel.

Basic Approach . . .

Sufficient capacity to serve connected load.

Provision for future load growth.

Adequate power-factor correction and voltage regulation for better and cheaper power.

Minimum number of circuits for simplicity.

Maximum protective features for safety and efficiency.

Necessary converting equipment to produce the required kilowatt capacity.

Field Reports

Current-Carrying Capacity of Portable Cable on Reels—Maximum current capacity and other factors affecting cable life, and suggestions for rating cables on reels. *Coal Age*, January, 1958, p 98.

Distribution of AC Power—How initial design, quality construction and system improvements provide mining operations with an efficient power system. *Coal Age*, March, 1958, p 116.

AC **for Deep Mining**—Advantages, maintenance benefits and voltage needs of underground AC systems. *Coal Age*, April, 1958, p 129.

More Economical Power Conversion—How a combination of ideas and equipment minimized cost, simplified maintenance and added portability to permanent substations. *Coal Age*, June, 1958, p 100.

Designs for Distributing AC Power—How better power for modern mining results from good design. *Coal Age*, August, 1958, p 78.

AC **Continuous Mining**—AC power distribution for an all-AC continuous mining setup. *Coal Age*, November, 1958, p 78.

AC **Operating Regulations**—How 23 states regulate the use of AC in coal mining. *Coal Age*, November, 1958, p 92.

Overcurrent Settings for DC Circuit Breakers—Guide to DC breaker settings based on feeder and trolley capacities and rail weights. *Coal Age*, December, 1958, p 96.

Wireless Control of 33,000-V Power—How two-way radios are used to monitor and control circuit breakers at main substations. *Coal Age*, March, 1959, p 82.

Plastic Cables for Deep Mining—Report on design, application and testing of plastic mining machine cables. *Coal Age*, April, 1959, p 122.

Cables for AC underground—Choice and illustration of cables for underground use. *Coal Age*, April, 1959, p. 90.

AC Service

AN ALL-AC MINE POWER SYSTEM starts with a main substation where power is purchased at a high voltage, usually 13,000. The main substation may reduce the voltage to the final levels of 220 or 440, or it may drop it only to 7,200 to 4,160 or 2,400 for transmission to load centers for final reduction. The number of voltage steps and the choice of voltages depends upon system load, transmission distance, safety and limitations imposed by mine laws. The usual practice is to omit the intermediate station. However, it is included in this report on AC to bring in all major variations in an AC system.

With the inclusion of the intermediate substation, the main divisions in an AC system are shown in the block diagram, while the one-line diagram shows the individual components making up each division. These diagrams employ the standard symbols and numbers adopted by the American Standards Association. These are used to promote familiarity with the electrical symbols used in circuit diagramming.

The Main Substation

ALTHOUGH MAIN SUBSTATIONS usually are owned by the power company, various switching and protective devices normally are coal-company property. The selection and arrangement of this equipment determines how well the complete system performs under normal and abnormal conditions. The best normally is as shown in the accompanying diagram for the main substation. What the units do is detailed in the following:

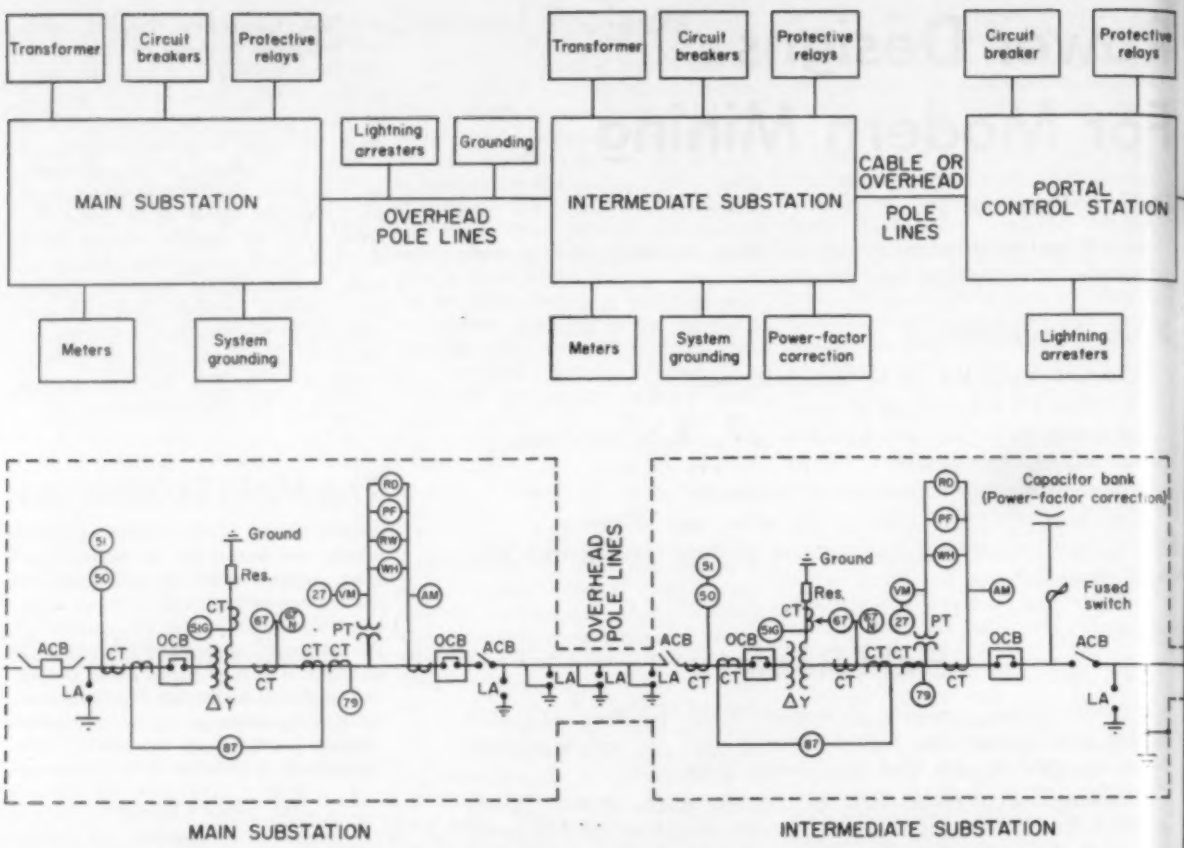
Air Circuit Breakers

Circuit breakers or disconnect switches are one of the protective devices used in electrical circuits. They are knife-blade-type disconnecting switches which provide a means of isolating transformers and associated equipment from the source of power. These switches are not installed in the line to interrupt load but are used as a visible means of isolating the equipment when repairs or construction work are being carried on. This type of switch provides a large air space between live wires and equipment which prevents leakage of power to the equipment. It also permits a visible check by

Where to Find It...

AC Service ..... p 261
Main substations . . . Overhead pole lines . . . Intermediate substations . . . Portal control stations . . . Underground distribution . . . Section control stations . . . Load centers . . . Utilization distribution

DC Service ..... p 270
Conversion capacity . . . Automatic operation . . . Portability . . . Transmission limits . . . Sectionalization . . . Ground protection

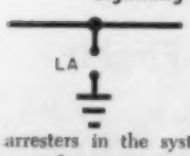


THE AC SYSTEM—Upper diagram shows the major divisions, including intermediate substation used in some systems and omitted in others depending upon the need. Lower diagram shows the AC-system components, per list below.

ACB—Air circuit breaker
LA—Lightning arrester
CT—Current transformer
PT—Potential transformer
OCB—Oil circuit breaker
Res—Resistance
51G—Time-delay overcurrent ground relay in neutral circuit
87—Differential relay
67—Directional overcurrent relay (phase)
67N—Directional overcurrent relay (ground)
50—Instantaneous overcurrent relay (phase)
51—Time-delay overcurrent relay (phase)
79—AC reclosing relay
27—Undervoltage relay
VM—Voltmeter
AM—Ammeter
WH—Watthour meter
RW—Recording wattmeter
PF—Power-factor meter
RD—Recording demand meter
85—Pilot wire receiving relay
74—Alarm relay
64—Ground relay

workmen that the system is disconnected from the power source. These switches are usually mounted on overhead pole lines and are opened and closed manually by insulated pole hooks that engage holes in each blade.

Lightning Arresters



Protection against overvoltage caused by lightning is accomplished by installing lightning arresters in the system. They are used to reduce power interruption and prevent equipment damage. How much protection against lightning a system should have depends on the location of the system and whether or not the location is subject to frequent lightning strokes. Installation costs vs. equipment value and lost time due to interruptions must also be considered.

Lightning strokes result in an overvoltage in the conductors. Arresters limit the accompanying surge by providing a path for it to travel between line and ground without permitting normal current flow. After a surge of lightning has been directed to ground, the arrester must prevent current in the system from flowing to ground. Summing up, arresters perform two operations: (1) direct the surge to ground and (2) stop the current in the system from flowing to ground after the surge has passed.

Several types of arresters are available for various applications:

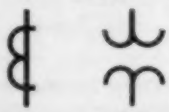
1. Distribution-type.
2. Line-type.
3. Station-type.

Distribution-type arresters are used to protect transformers, cables, capacitors, meters and circuit breakers. They are designed to permit mounting on poles and crossarms. They are relatively inexpensive and are easy to install.

Line-type arresters are similar to the distribution type but are more suited for protecting small equipment.

Station-type arresters provide better protection than the other two. They are used, as the name implies, to protect stations and other equipment of extreme importance.

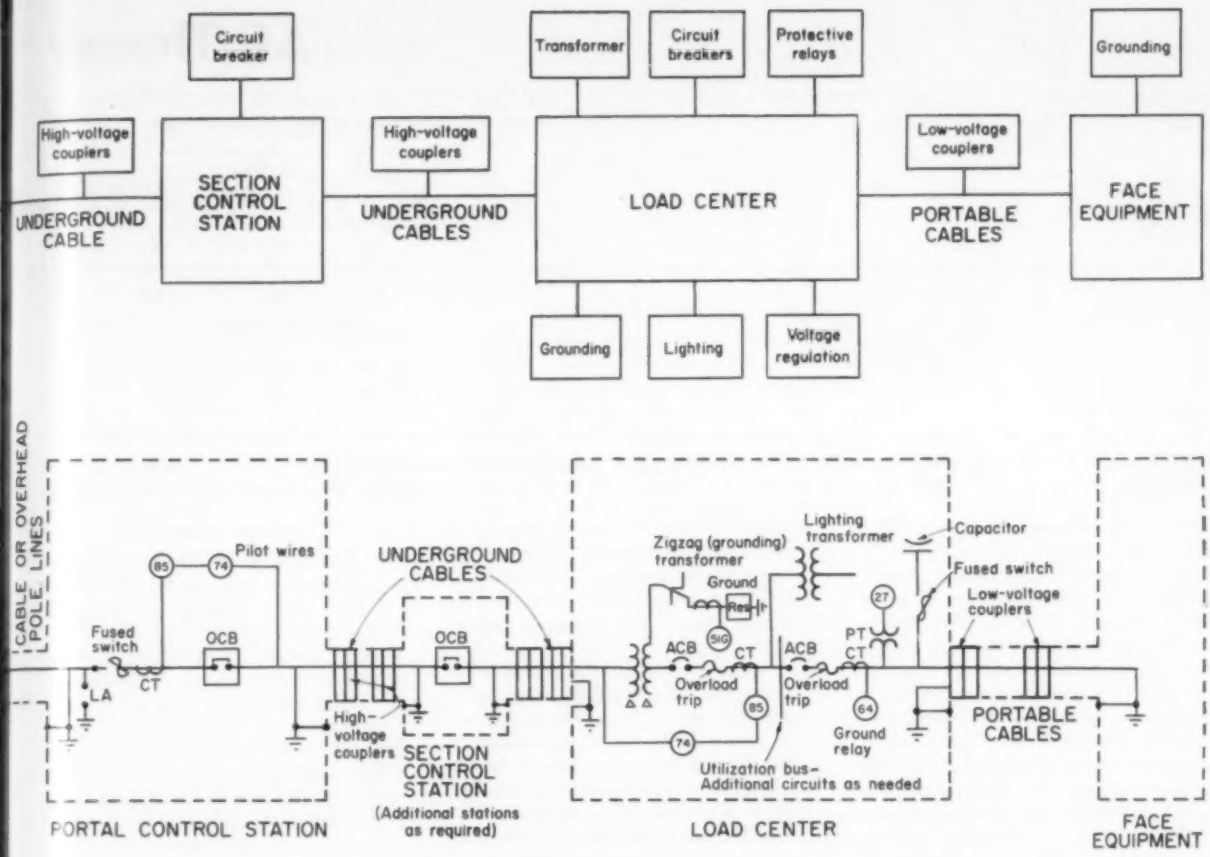
Current Transformers



The next symbol in the one-line diagram represents a current transformer. A discussion on this component along with potential transformers, will appear later in the section on relays since their function is concerned with the application of relays.

Oil Circuit Breakers

On high-voltage systems the oil type circuit breaker is used



to guard against overloads or short circuits, and also to permit sectionalizing the system to isolate trouble. It should be noted, however, that air circuit breakers are being used more and more on high voltage systems. The amount of protection that an oil circuit breaker provides depends primarily on the relays associated with it. These will be discussed later.

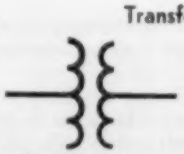
Circuit breakers are normally designed for momentary and interrupting rating, and with automatic interrupting features. Momentary rating is the amount of current that a breaker will withstand, including short circuits from all sources. The breaker should safely open on any current within its rating.

The interrupting rating is the ability of a breaker to interrupt a fault current between the maximum and minimum designed voltage rating of the breaker. The rating is measured in megavolt-amperes, abbreviated *mva* or *arc kva*. The *mva* value is determined by multiplying the kilovolt rating of the breaker by the kiloamperes of the fault current to be interrupted. The *arc kva* value is found by multiplying the kilovolt rating and the amperes.

Interrupting fault currents automatically is achieved by built-in tripping devices or by relays connected to the breaker. There is a wide variety of relays to choose from and the selection depends on the amount of protection required.

Facilities at the main substation normally consist of a master oil circuit breaker (one that provides protection for the overall system) and several branch circuit breakers that feed various loads. The master breaker provides additional back-up protection in case a branch circuit breaker fails to operate when a fault occurs in any one branch. The purpose of branch circuit breakers is to isolate trouble in a particular branch without interrupting service to the other branches.

Transformers



The primary function of a transformer is to change electrical power from one voltage range to another. This makes it possible to transmit, distribute and utilize AC power at the most economical and effective voltages. Unlike AC, DC power must be transmitted from converters, generators or rectifiers to working areas at essentially the same voltage. This imposes a limit on the amount and distances DC can be transmitted.

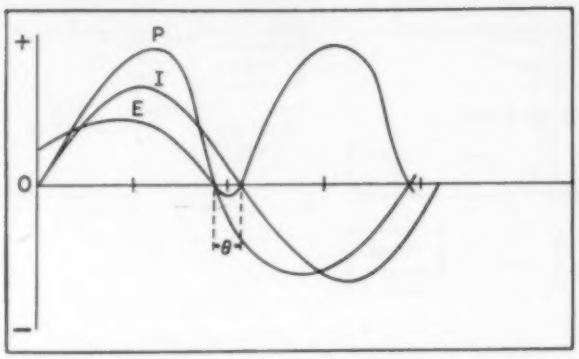
Transformers contain primary and secondary windings. The primary receives current at the input voltage and the secondary sends it out at the output voltage. The ratio of primary to secondary voltage is the same as the ratio of turns in the primary and secondary windings.

Practically all transformers are single-phase or combined three-phase units, the latter combining all phases in a single case or tank. A three-phase distribution system may employ a single three-phase transformer or three single-phase transformers. The selection is usually a matter of preference. Single-phase units are in the majority but three-phase transformers are gaining in popularity.

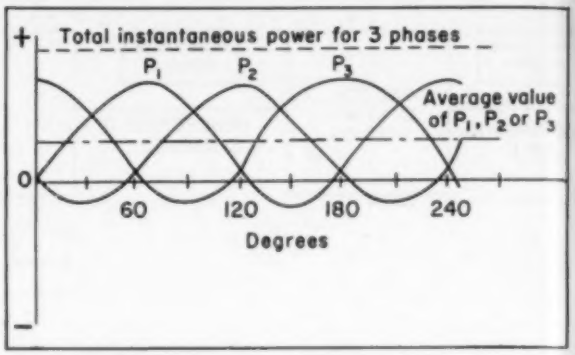
In an AC system, the extent of transformation depends on the size of the system (load demand), distance voltage is to be transmitted and voltage limits imposed upon the system by mine laws. Distribution voltages for mining normally range from 13,000 to 220 with transformation taking place as lower voltages are required.

Transformer connections in distribution system are normally delta-Y or

AC Theory



CURRENT (I), VOLTAGE (E), POWER (P), AND POWER FACTOR (θ) in an AC system normally take a wave form.



TOTAL INSTANTANEOUS POWER of three-phase and single-phase AC systems is indicated by the dash lines.

WHAT IS AC and how does it differ from DC? Webster defines AC as "a periodic electric conduction current which reverses its direction at regularly recurring intervals. As used in electrical engineering practice, its frequency is determined by the frequency of the alternator supplying it and its successive half waves are similar in shape and area. The standard commercial frequencies are 25 and 60 cycles per second." This means that with AC the current flowing in electrical conductors alternates between positive and negative at a rate of 25 or 60 cycles per second. One complete cycle (360 deg) consists of a half positive and half negative wave, each similar in shape and size. In comparison, DC flows in one direction, always with positive polarity.

Inductance and Capacitance

When current flows in conductors, a voltage also is impressed across the conductors. It can be represented by a wave similar to the current wave. The voltage wave reverses its direction ahead of or behind the current wave, depending on the amount of inductance and capacitance in the circuit. The degrees of difference between the two waves at zero is called the phase angle and is the number of degrees by which current lags or leads voltage. The accompanying sketch shows the current lagging. This angle of lag or lead is also related to power factor. The cosine of this angle, termed Cos θ, is the power factor.

When current lags the voltage, the power factor is said to be lagging and the circuit is predominantly inductive. Inductance is opposition to the flow of AC and is present in AC circuits and conductors but not DC. It is produced by a magnetic field which induces a voltage in such a direction as to oppose the change causing it.

A circuit has a leading power factor when the current leads the voltage. It then is predominantly capacitive. Capacitance oppose changes in voltage and is produced by an electric field set up around the circuit or conductor when current is present. When voltage increases in a circuit energy is transferred from the circuit to the electric field and when it decreases, energy is transferred from the electric field to the circuit. This indicates that energy is stored in the electric field and, when the voltage in the circuit decreases, this stored energy tends to give the line voltage a boost, attempting to maintain a constant voltage while load fluctuates.

Power from AC

The product of current and voltage produces still another wave form called power and is analagous to power produced in a hydraulic system. The force of a stream of water reflects a combination of pressure in pounds per square inch and volume in gallons per minute. In an electrical circuit voltage is the pressure and current is the fluid. Although voltage and current are negative during half their cycle, the power wave is almost always positive. It reverses direction at the phase angle between voltage and current and assumes a negative polarity for a short time only. This, and the fact that power transfer is not constant in magnitude, i.e., pulsates with time, are undesirable features in AC. However, these disadvantages are small compared to DC, mainly because AC permits the use of transformers.

Power in an AC circuit depends on the voltage between conductors, the current flowing in the conductors and the power factor. The higher the voltage the lower the current and the lower the current the smaller the wires which can be used to transmit it. Transformers enable power to be stepped up or down as the case may be. When power is to be transmitted

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delta-delta. These symbols or names have been applied to the different connections because the actual connections resemble these symbols. The delta-Y connection is used on higher voltages and delta-delta on lower voltages. However, this is not a final rule.

Most transformers are equipped with tap changers to change the ratio of the winding. The primary purpose of taps is to increase or decrease the voltage level of the system. Tap-changing does not affect the voltage drop or improve voltage regulation.

Transformers are rated in terms of kilovolt-amperes (*kva*). The prefix *k*, or *kilo*, is equal to 1,000 and is used primarily to reduce volt-ampere values to more convenient number; for example, a 150-kva transformer is the same as a 150,000-va unit.

Since the voltages of transformers are fixed, the rating of an individual unit is determined by the amount of current flowing through it. Care must be exercised in selecting the correct rating to insure efficiency and adequate power for the system and loads, but capacity should not exceed the horsepower rating of the system by any great degree because it results in an increase in wattless current and the imposition of a greater false load on the system.

and Principles

over long distances it is better to use a higher voltage, thus reducing line drop and wire size. At the end of the transmission line it can be stepped down to the desired voltage level.

Mutual inductance is the phenomenon on which both transformers and AC motors operate. A characteristic of the AC circuit is the fact that it produces a flux—the equivalent of current in a magnetic circuit — which links it with another circuit near it. As the current in the first circuit changes (alternates) it causes a change in the mutual flux which in turn induces a voltage in the second circuit. Induction does not take place in a DC circuit because the current does not change. Therefore, it is not possible to use transformers in DC circuits.

It was noted previously that the instantaneous power wave is negative for a short time. In other words, as the wave travels from positive to negative and back to positive, it becomes zero for an instant. Bear in mind that this is an instantaneous wave and that there are 60 of these waves (cycles) per second which produces an average positive wave over a period of time.

This pulsating or alternating action of the power wave does, however, affect the performance of single-phase motors. On the other hand, three-phase motors do not have this pulsating action.

The difference between the two can best be understood when it is realized that three single-phase power waves are impressed upon the stator of a three-phase motor at the same time, while the single-phase motor has only one wave impressed upon its stator. The combined average instantaneous power wave of the three phases results in a constant wave, thus eliminating the pulsation present in each line of the system. This is the main reason why three-phase motors are more widely used.

From purchased power to actual utilization voltage, AC power offers many advantages. However, AC has more elements of regulation than DC. These elements include power-factor, line reactance and high motor starting currents. The elements of concern in DC are resistance and low motor starting currents.

Power Factor

The power factor of a circuit, as noted previously, is the cosine of the angle of lag or lead of the current with respect to voltage. If an AC circuit contained only resistance there would be no problems with power factor because, in a pure resistive circuit, the current and voltage are always in phase. But, in AC there are two other elements to contend with. These are inductance and capacitance, as explained previously, and they are the reason why voltage and current are never in phase in an AC circuit. These elements do not contribute anything to the average or active power, or the power that performs useful work in an AC system. As the current and voltage increase and decrease, energy is transferred between the magnetic and electric fields and the circuit. The effect of this transferring of energy is a false load that burdens the system as much as an actual load. This energy is called reactive or wattless power. It is measured in reactive volt-amperes and is abbreviated *var* or *kvar*.

Thus, an AC circuit contains two types of power: first, one that performs work (active or average power) and, second, one that does not (reactive or wattless power).

When a circuit has a poor power factor it is usually a result of inductive loads in the system. Since inductance causes a lagging power factor and a capacitance a leading power factor, it follows that the addition of capacitors to a circuit would tend to reduce the lag. This would tend to improve the power factor by causing it to approach 1 or 100%, which is unity power factor. However, it is not economically possible to have a unity power factor. A 0.95 or 95% power factor is considered good.

Line Reactance

Two types of reactance exist in AC transmissions lines and again these are inductive and capacitive. They affect the transmission of power just as in other circuit equipment. Basically, reactance is the sum of the inductance and capacitance in a circuit. The amount of reactance in transmission lines depends, in part, on the spacing and size of the conductors.

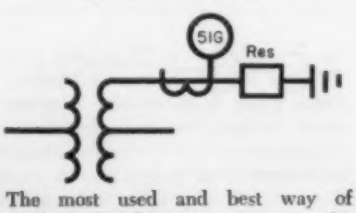
High Starting Currents

Current required to start an AC motor depends on the characteristics of its load and the starting method employed. Generally, a motor requires several times its normal current during the starting period. The rotor resistance also determines the amount of current that a motor will consume to produce a needed torque. High rotor resistance produces high torque and low rotor resistance produces a low torque. The load that the motor will be required to handle will determine the rotor resistance. Higher resistance causes power factor and efficiency to decrease.

In AC motors, low voltage affects the torque as the square of the voltage but speed is maintained. On the other hand, DC motors tend to lose speed but maintain torque.

Pull-out or maximum torque of an AC motor is attained when the load applied to the rotor causes the rotor to slow down and fall back in space-phase far enough to lag the rotating stator field by 90 deg. When this angle is exceeded the motor stalls. The pull-out torque limitation of AC motors is one reason why such motors are not used on haulage locomotives. In many instances it would be impossible to get a trip started because the torque would be so great that the motor would probably stall.

System Grounding



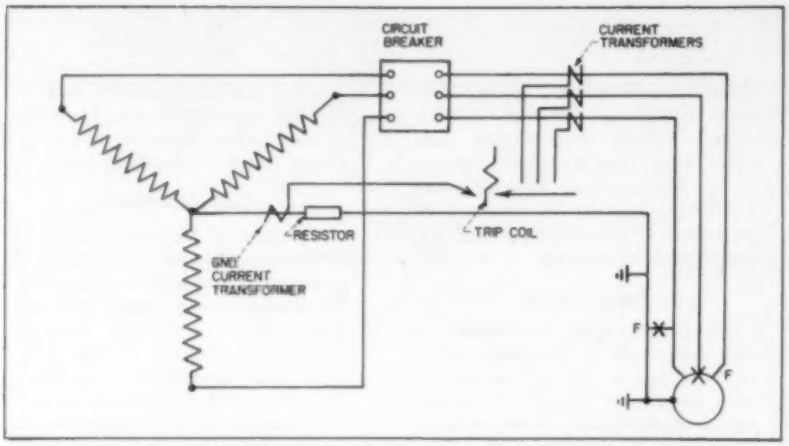
The most used and best way of grounding distribution systems is the neutral ground method. Since it provides better protection and is simpler, discussion will be limited to this system.

Neutral grounding connections can be obtained in two ways:

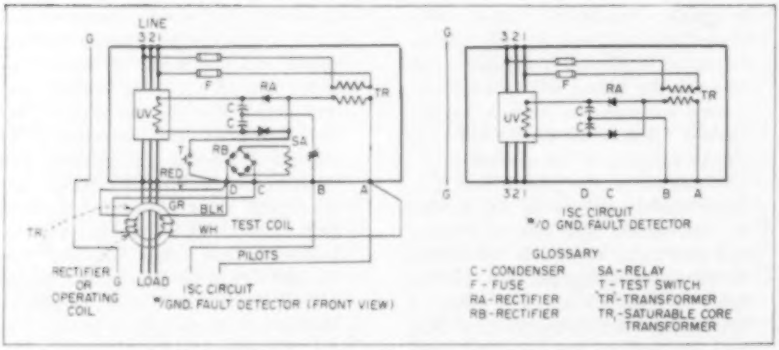
1. Connect transformers delta-Y.
2. Use zigzag grounding transformers when delta-delta connections are used.

The chief advantages of the delta-Y connection are that it provides a neutral connecting point for grounding purposes, and is the simplest and best way of stabilizing the Y secondary neutral. This method does not require extra equipment to establish a neutral.

If the system is connected delta-delta, there is no neutral connection point available. However, a neutral can be established by installing zigzag grounding transformers. They consist of a three-phase winding with a secondary. Each phase of this transformer is connected



AC CIRCUIT PROTECTION by grounding transformer circuit to neutral of Y-connected transformer secondary.



CONTROL CIRCUIT for modern AC system with and without ground-fault detector.

to a different line of the system. The grounding transformer neutral is then the same as in the Y-connected system.

When a neutral has been established for the system, there also must be a method of grounding the neutral. The most desirable practices in mining are: (1) resistance grounding and (2) solid grounding. Resistance grounding is more widely used, especially underground.

In resistance grounding the neutral is connected to ground through one or more resistances regardless of whether the neutral is connected delta-Y or delta-delta with a grounding transformer. The main reason for using resistors in the grounded-neutral system is to limit the amount of current during faults. The advantages are as follows:

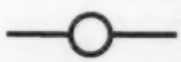
1. Minimize electric shock hazards to personnel.

2. Reduce burning effects in faulted electric equipment.

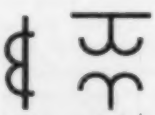
3. Reduce mechanical stresses in circuits and equipment.

Solidly grounded neutrals are connected directly to ground without any provisions for limiting current. The disadvantage of this method is that personnel are exposed to large ground currents when faults occur.

Relays



Relays detect trouble in a distribution system. They are used in conjunction with circuit breakers to control the operation of breakers when faults occur.



(Current and Potential Transformers — Relays are connected into the system through current or potential transformers, often called instrument transformers. Their purpose is to insulate the relays from line voltage and to reduce line current and voltage to values that can be applied to the sensitive mechanisms that are common in relay design. Current transformers are connected in series with the transmission lines. Potential transformers are connected across the lines. These transformers operate on a fixed ratio, for example, a current transformer having a 600- to 5-amp ratio will deliver 5 amp to the relay when a current of 600 amp flows in the line.)

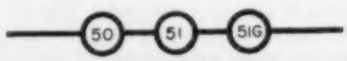
Relays are classified with respect to the rate of speed at which they operate. Basically, these classifications are: (1) instantaneous, (2) high-speed, (3) time-delay and (4) combinations of the three.

Instantaneous relays, as their name implies, operate within a few cycles after faults are detected. High-speed relays differ from instantaneous in that they operate within three cycles or less.

Time-delay relays are those that do not operate until a predetermined time has elapsed. The time ratings are usually adjustable but there are a few that have the time rating built into them.

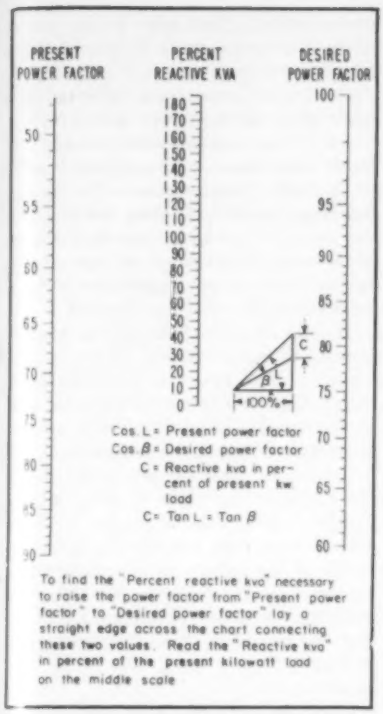
Distribution systems can be protected from almost any fault condition that might develop within a system by proper selection and coordination of relays. The various relays are named with reference to the protection they provide. Those most often used are: (1) differential, (2) overcurrent or undercurrent and overcurrent directional, (3) overvoltage or undervoltage, (4) phase balance and (5) reclosure. All are available in various time ratings. There are of course other relays but space does not permit complete coverage.

Differential Relays —These relays operate on current induction and are used to protect AC equipment from internal faults in individual equipment or faults in sections of distribution systems, including transformers, various rotating units and transmission lines. When used on transformers, they operate on a fixed percentage of unbalance (approximately a 50% ratio) between the primary and secondary windings. The principle of the differential relay is that what enters must leave, except that with transformers the ratio will be different, but this difference is compensated for by using current transformer with corresponding ratios. These relays monitor the current of an electrical system or equipment. When the rated percentage of unbalance is reached the relay operates a breaker and interrupts service until the fault is corrected.



Overcurrent Relays—These relays are used to trip circuit breakers when abnormal currents of two to three times the normal flow in the circuit. They are adaptable to transmission lines, buses, feeder circuits, transformers and motors.

Directional Overcurrent Relays — These differ from straight overcurrent relays in that they are primarily used for ground protection. They are designed to measure fault current in one or two directions. Whether faults will cause flow in one or two directions is determined


PRESENT POWER FACTOR
PERCENT REACTIVE KVA
DESIRED POWER FACTOR
Cos. L = Present power factor
Cos. β = Desired power factor
C = Reactive kva in percent of present kw. load
C = Tan L - Tan β
To find the "Percent reactive kva" necessary to raise the power factor from "Present power factor" to "Desired power factor" lay a straight edge across the chart connecting these two values. Read the "Reactive kva" in percent of the present kilowatt load on the middle scale

BEST METHOD OF CORRECTING POWER FACTOR in a given case can be determined by a careful study of surrounding conditions. Without taking into consideration special features, the amount of corrective KVA may be determined by the use of the above nomograph copyrighted by Westinghouse Electric Corp.

by system conditions. The two-directional relay is used on transmission lines where ground-fault currents flow in either direction. These relays provide directional as well as overcurrent protection. Other directional relays provide phase protection.

59 Overvoltage Relays—These serve primarily the same purpose as over-current relays except that they are connected in the line by potential transformers which measure the voltage across the lines. When an overvoltage exists the relay operates and opens the circuit breaker. Overvoltage relays are not too frequently used in main substations but are included in the list because they can be employed.

27 Undervoltage Relays—Like undercurrent relays, undervoltage relays indicate when voltage is not up to the level it should be. Undervoltage values result in the breaker tripping and staying out until the undesirable condition is corrected.

46 Phase-Balance Relays — These protect the system from faults occurring in any phase of the three-phase system. Quite often a fault current will not be large enough to trip the overcurrent relay but will operate the phase-balance mechanism, which is more sensitive, because of an unbalance in the three phases.

79 Automatic Reclosing Relays—These are used to automatically reclose electrically operated circuit breakers. They limit the duration of power failures in many instances where faults clear themselves quickly. Most reclosing relays attempt to close a breaker three times before locking it out. The time interval between reclosures is predetermined. Lock-out means that after the third attempt to keep the breaker in fails, the relay will not function until it is reset manually. Such relays can be designed to operate more than three times before locking out, with the number of reclosures depending on the requirements and design of the system.

With the wide variety of protective relays available today, no distribution system need operate without complete protection against faults. However, it is possible to overprotect a system or to have relays that will not operate under fault conditions if selection and arrangement have not been coordinated.

Meters

Meter Indicating and recording meters or instruments are used to measure the different value of voltage, current and power in distribution systems.

VM Voltmeters —Voltage values need to be checked frequently to insure that an adequate voltage level is maintained. Voltmeters are used for this purpose and are connected in parallel or across the transmission lines. They measure the average voltage of the system and normally are of the indicating type which shows the voltage level as it varies with the applied loads.

AM Ammeters — Current (amperes) is measured by ammeters connected in series with the transmission lines. They indicate the extent of the load the system is pulling and show whether or not it is overloaded.

W RW Power Meters — Power is measured in watts and watthours, and when large quantities are consumed the units of measurements are kilowatts (*kw*) and kilowatthours (*kwhr*) and are derived by dividing the basic units by 1,000. Basically, there are three types of wattmeters: (1) indicating, which show the average rate at which power is consumed, (2) recording, which record the average value on special graph paper and (3) watthour, which sum up and record the total energy consumed during an interval of time.

Actually these meters consist of a voltmeter and ammeter combined. The voltage and current values are converted to power by means of voltage and current coils in the meter. They indicate the average power delivered to the system, and, are connected in the same manner.

PF Power-Factor Meters—Another value of importance that needs measuring is the power factor of the system. Meters for this purpose indicate the relation of the phase between the line current and line voltage which actually is the same as the power factor of the load.

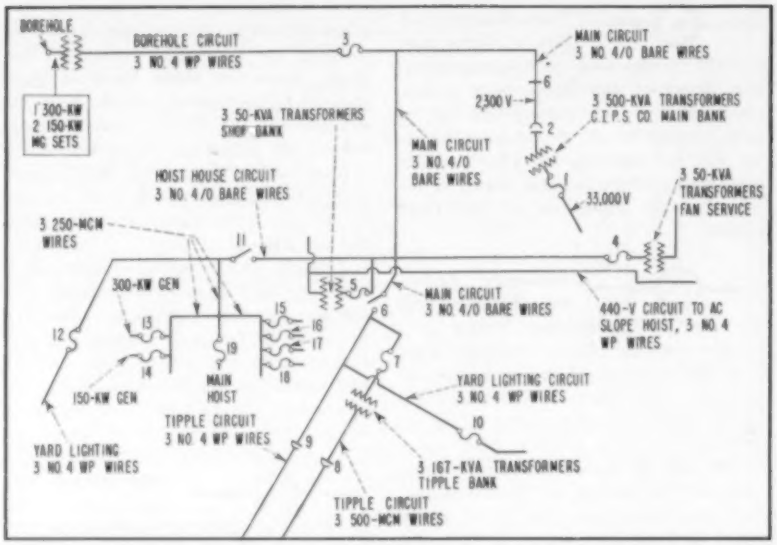
RD Demand Meters—Still another value that must be measured is the rate at which power is consumed. Instruments or meters for measuring the maximum demand during an agreed period of time, usually a month, are known as demand meters. The demand or peak power is the maximum amount of energy consumed in any consecutive number of minutes, say 15 or 30 min, during the month. Demand is measured in kilowatts and is the average rate of consumed energy during the peak period. This method of establishing the maximum demand rate does not penalize the company for very short peaks. However, if the peak lasts the full set-time interval of the meter, a penalty would be imposed upon the company.

The next three components appearing in the one-line diagram are an oil circuit breaker, a disconnect switch and a lightning arrester. These have been discussed previously under their respective headings.

Overhead Pole Line

MOST DISTRIBUTION SYSTEMS include overhead pole lines even though, in some instances, they are short. The two-step voltage arrangement normally requires more overhead construction than the one-step system. Transmission of high voltage from main substation to intermediate substations often involves several miles of overhead power lines.

The following discussion on overhead pole lines will be limited to the electrical factors affecting the transmission of volt-



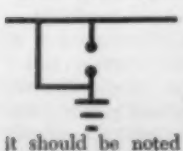
PROTECTIVE EQUIPMENT IN AC SYSTEM for new mine is shown by numbers: (1) primary fused cutouts; (2) secondary breaker; (3) 100-amp fused cutout with 80-amp links; (4) 50-amp fused cutout, 30-amp links, fan circuit; (5) 50-amp fused cutout, 50-amp links, shop transformers; (6) pole-top switch, 3-pole gang-operated, 7.5-kv, 400-amp, tipple circuits; (7) 200-amp 7.5-kv trip-out fused cutout, 125-amp links, tipple transformer bank; (8) 600-amp OCB, tipple circuits; (9) 400-amp OCB, tipple circuit; 50-amp fused cutout, 2-amp links, yard lights; (10) disconnect switch, 7.5-kv, 400-amp, hoist-house circuit; (11) 50-amp fused cutouts, 2-amp links, yard lights; (12-13) 200 amp fused cutouts, 5,000-V 200-amp links, 300-kw m-g set; (14) 200-amp fused cutouts, 5,000-V 150-amp fuse links, 150-kw m-g set; (15-18) 50-amp fused cutouts, 50-amp links, compressors; (19) 200-amp fused cutouts.

age (line reactance), grounding and lightning protection.

Line Reactance

Reactance, discussed in the section on AC theory, is caused by the inductive and capacitive characteristics of AC transmission lines. The spacing of conductors determines, in part, the amount of reactance in transmission lines which, in effect, causes voltage drop and poor power factor. Lines spaced far apart produce more adverse effects on each other than lines spaced close together. To reduce reactance, lines can be spaced closer together but this has its limits in overhead pole line construction.

Two other step factors help to reduce line reactance. They are the size and type of conductors with respect to radius and surface conditions. For the average mine setup, these two factors have very little effect on the amount of reactance in the system. Conductors are usually selected in accordance with the transmission distance and voltage level.

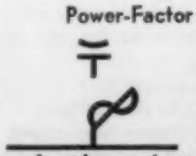


System Grounding and Lightning Protection—See discussion earlier in this report. In addition, it should be noted that a ground wire normally accompanies the power conductors, with lightning arresters installed at intervals of approximately 1,500 to 2,000 ft. The ground wire is connected to the ground side of the lightning arresters. This method has proved most satisfactory and is widely used in mine distribution systems, although it is not uncommon to find a system without a ground wire.

Intermediate Substations

SINCE MOST of the components included in the main substation are also used in the intermediate substation the reader is referred to that section of this report for a discussion of their purpose and application. It should, however, be noted that protection for intermediate substation should be as complete as the main substation. The rating of the components will be correspondingly less with lower voltage and load. Power-factor correction is the only major variation.

Power-Factor Correction



There are few AC systems that do not require power-factor correction. Correction can be made either at the substation for system correction, at the load for individual correction or both. This latter is not an uncommon practice. As a matter of fact, power-factor correction is being treated with as much importance today as any other phase of the power system. Once the money-saving potentials of power-factor correction are recognized, it will be applied to more systems. The saving is not in power bills alone but also in the reduction of load on the system which permits equipment to operate on a more normal power supply, thus reducing repair bills on the equipment.

The device most often used in mining systems to correct power factor is the capacitor. This, however, is not the only means. Other correction includes the use of synchronous motors, and the proper application of any induction motors.

Capacitors can correct and bring power factor up to 90 to 95%, which normally takes the mine out of the penalty area and reduces the reactive power in the system. Some systems may require overall correction and also correction at the center of groups of induction motors. Still other systems would require correction at only one of the two locations.

Correction at the intermediate substation consists of installing a capacitor bank with sufficient *ckvar* (capacitor kilovolt-amperes-reactive) to bring the power factor to the desired rating. The *ckvar* value is determined by the amount of *kw* and *kvar* of the system. From these values the *kva* and power factor can be calculated.

Shunt-type capacitors are used in most cases. They are made up of a group of conductors, usually plates, so arranged that a large electrical charge can be stored in them. Electrical charges are stored when a potential difference exists between the conductors. Putting it another way, a capacitor stores electrical charges when the potential of the conductors is increasing and discharges it when the potential is decreasing.

Why capacitors actually correct power factor might be better understood if the inductance is considered positive and the capacitance negative. Thus, when capacitance (*ckvar*) is added to a circuit it subtracts from the inductance (*kvar*). Therefore, the *kvar*, or reactive power is reduced, which improves the power factor.

Portal Control Station

AT THIS POINT of the installation there are several standards for distributing AC power underground. These standards provide safety for men and equipment and contribute to an efficient underground distribution system.

The power should enter the mine as

near the load center as possible for two reasons:

1. To reduce the amount of high-voltage cable underground.

2. To minimize voltage drop between the substation and load center.

In most cases the substation—in this instance the intermediate, though it could be the primary unit in a one-step voltage-reduction system—will be located near the place where power is taken underground. Consequently, it is not necessary to provide an extra switching station equipped with circuit breakers and necessary protective relays, such as overcurrent and phase balance, as well as ground-fault detectors and lightning arresters. The intermediate substation is equipped with these devices. On the other hand, if the entrance is located some distance from the intermediate substation it would be necessary to provide a separate installation including all the devices listed. These components were covered earlier in this report. However, the ground detectors are quite different, as indicated in the following.

Ground Protection

Protection of underground high-voltage systems can be achieved in several ways but probably the best method is the pilot-wire system employing the differential-type relays previously described. A small amount of line current is permitted to flow in the pilot wires through the secondary of current transformers. These pilot wires are carried with the power conductors.

Pilot-Wire Relays—Referring to the previous discussion of differential relays, these operate on a balance principle. The amount of current at one end of the line is the same as at the other end. When the current in the pilot wire becomes unbalanced, due to faults in the line, the relay operates and opens a circuit breaker. This method provides phase-to-phase as well as ground-fault protection.

Alarm Relay—An additional feature of this protective system is a relay for continuously checking the condition of the pilot wires. If the wires become short- or open-circuited, the relay will operate, indicating that the system is no longer protected against faults. The lines can then be inspected and repaired.

Underground Distribution

IN CONJUNCTION with the surface switching arrangement, high-voltage cables entering the mine through boreholes or shafts are equipped with circuit breakers at the bottoms of these openings to interrupt power feeding into the mine in case of emergency and also for repairs.

Cables

Insulated multiple-conductor cables equipped with ground wires and a conducting shield over both ground and power conductor are used to transmit high voltage underground. Type SHD cables with adequate kilovolt rating are used in most installations. The length of these cables normally is kept to a maximum of 1,000 ft. They are connected by high-voltage couplers or potheads.

Couplers

From a safety viewpoint it is better to use couplers equipped with mechanical locking. This permits only authorized personnel to disconnect the couplers, and also eliminates the possibility of persons connecting them while repairs are being made.

Section Control Station

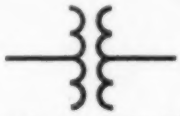
AS TRANSMISSION DISTANCES increase, it is necessary to sectionalize the cables at intervals of approximately 2,000 ft. This means that a circuit breaker or other disconnecting device is installed in the line at these intervals. This also applies to branch circuits that feed other sections of the mine. In addition to the circuit breaker these branch circuits should include necessary protective equipment of the same order as that required when the cables first entered the mine.

Load Centers

THE HIGH-VOLTAGE CABLE is terminated at the load-center with the same type of coupler used in the intermediate sections, with one half of the coupler permanently mounted on the load center frame. The power conductors are connected to the transformer and the ground wires are grounded to the frame.

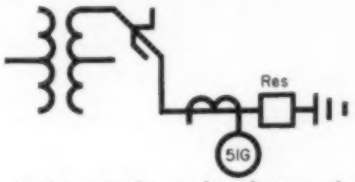
The purpose of the load center is to reduce the high voltage to actual utilization voltage and to provide switching and fault protection to the branch circuits that it will supply power to. It is a combination power and distribution center. However, individual units may be installed for the same purpose, although the combined unit seems to be preferred.

Transformers



Dry air-cooled or inert gas - filled transformers can be used underground. The former are more widely used because, among other things, the liquid-filled units must have a separate split of air when installed underground.

System Grounding



As shown in the one-line diagram, the transformer is connected delta-delta and uses a zigzag grounding transformer to establish a neutral. The neutral is resistance grounded and contains the same ground relays as the intermediate substation.

Circuit Breakers

Back-up protection is provided for each branch or bus circuit by installing a breaker between the transformer and bus. This gives added protection when relays are properly coordinated. It is, however, possible for both breakers to trip at the same time which would cause a delay in the other branch circuits. But, in most instances, when a fault occurs in any one branch it will trip only the branch circuit breaker and not disturb the others.

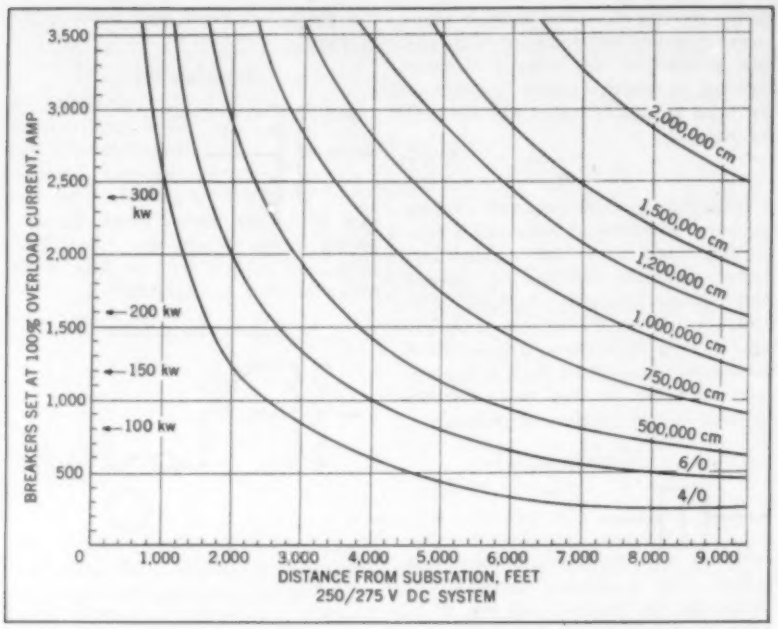
Circuit breakers used most often in underground load center are of the stationary mounted molded-case type but other types also are used. They can be equipped to provide overload, overcurrent and undervoltage protection.

Relays

Protective relays accompany main as well as branch circuit breakers. The relays employed in load centers provide overload, overcurrent and undervoltage protection.

Overload Relays—These are used to protect the branch circuits against overloads growing out of motor operation. The tripping device is built into the circuit breaker. Instantaneous overload generally will not trip the breaker but overloads lasting for several minutes will result in interruption.

Overcurrent Relays—These are used for ground-fault protection. They



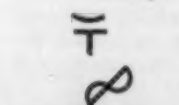
LIMIT OF CURRENT FLOW in a DC circuit at various distances from substations for various sizes of conductors is shown in the above chart.

require the use of current transformers and an established ground conductor in each individual branch circuit of the portable cable supplying power to face equipment.

To obtain ground protection in each branch circuit, current transformers are connected in each phase of each branch. The most effective and accurate current transformer for this application is the loop or ring unit. They are not as sensitive to small unbalanced phase loads as other types. Ground faults, on the other hand, cause unbalanced currents to flow, which operate the relay and in turn open the circuit breaker.

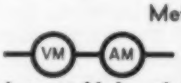
Undervoltage Relays — These are used primarily because AC motors do not operate efficiently on low voltages. The relay serves as a signaling device to warn operators that the voltage is not sufficient for good motor performance. When this condition exists, the obvious solution is to move the load center closer to the center of operations in the active mining zone.

Voltage Regulation



Due to the high starting currents of AC induction motors, it is often desirable and sometimes necessary to install capacitors at the load center to maintain a good power factor and to compensate for voltage drop during the starting period. The benefits of capacitors will in most cases, offset the cost of installing them. Power factor correction, discussed earlier in this report, would also apply.

Meters



The only measurements of power that would be of benefit at the load center are voltage and current. Whether these values should be measured in each branch or bus circuit is a matter of choice. This information, in many instances, can be of value with respect to the operation of the face equipment.

Utilization Distribution

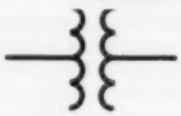
THE ELEMENTS of concern at this point in the distribution system are cables, couplers and ground continuity. Once cables and couplers are installed, the only everyday task remaining is checking ground continuity. This is vital if safety for men and equipment is to be maintained.

Portable cables used in AC utilization are normally Type G—a three-conductor cable with an insulated ground conductor. Cables usually are sectionalized in 50- and 100-ft lengths so that their bulk will not be excessive. Keeping cables short helps to reduce voltage drop.

Couplers attached to the ends of the cable sections should be designed to prevent injury to persons connecting and disconnecting them.

Ground-continuity checking devices are difficult to maintain in portable cables, especially those that are spooled on reels. To date there is no effective way of checking this operation other than by test by maintenance personnel.

Lighting Transformers



Power for section lighting can be obtained from the main load center transformer or by a separate transformer installed for that purpose only. When the main transformer is used a voltage stabilizer is needed to reduce flicker which is caused by fluctuating loads in the system. Consequently, a separate source is more desirable since it is independent from the power system and provides a constant voltage for lighting.

DC Service

CONVERSION EQUIPMENT INCLUDES the old-reliable converters and m-g sets, but the standard unit today is the mercury-arc rectifier, including the glass-bulb type. A few metallic rectifiers of the selenium type are in service and units based on germanium, silicon and other metals are under consideration for possible use in the future.

CONVERSION CAPACITY—Higher horsepower per machine and per section is requiring an increase in the capacity of rectifiers and other conversion equipment. A recent series of tests on power required by continuous miners indicates that the capacity for a single section (miner and shuttle cars, roof drill, etc.) should be at least 200 kw.

Dull bits on miners and other equipment have a major effect on power demand and consumption. In one test with dull bits, miner advance was 20 ft, demand was 82.4 kw and consumption was 32.47 kwhr. Time was 50 min. With sharp bits, advance in 54 min was 30 ft. Demand was 69 kw and consumption was 31.33 kwhr (J. O. Cree, 1956 Coal Convention, American Mining Congress).

AUTOMATIC OPERATION — The high cost of labor naturally dictates making substations automatic unless attendants can grind bits, splice cables or perform other duties. Equipment now is available for checking position and operating breakers at will from a central station several miles away (*Coal Age*, October, 1955, p 68). The system is based on carrier current using telephone lines for transmitting audio signals.

PORTABILITY—For the maximum in convenience and efficiency, the trend is toward portable conversion units. Such units also may be placed in permanent locations—to serve main-line haulage, for example. Or stationary types may be employed at some saving in cost.

Portability facilitates keeping transmission distances short. However, if the cover is shallow, some mines have felt that the lower cost of pole lines and surface facilities, even when offset by the cost of boreholes, warranted keeping conversion equipment on the surface, even with 275 V as the nominal voltage. With 550 V, the reduction in number of moves otherwise necessary is an added reason for considering keeping conversion equipment outside.

Heavy locomotives bring up the problem not only of placement and capacity of substations but also the effect on the remainder of the system as the locomotive passes a given point. To reduce disturbance in face operation as a result of locomotive operation, substations may be equipped with automatic load distributors.

THE INVERTED TROLLEY—For locomotive operation, a newcomer in service is the inverted trolley (*Coal Age*, October, 1952, p 87). As the name implies, the trolley is placed on top of inverted hangers, and the locomotives receive power through sliding shoes pulled by cables.

Transmission Limits

The maximum distance DC can be transmitted from the substation depends on a number of factors, and must be calculated for each individual operation. Balancing everything, the distance should not exceed 3,000 to 3,250 ft for an 800-amp average transmission, 300 V at the nips and 250 V at the machine.

Even with the maximum in feeder capacity it is difficult to maintain adequate voltage, let alone rated, for 250-V motors at distances much over 4,000 ft. Incidentally in increasing feeder capacity, it is better to use a number of smaller cables than one large one because the current-carrying capacity is greater. At 30C ambient temperature, 45-deg rise, for example, approximate ratings are: 500,000 cir. mils, 800 amp; 1,000,000 cir. mils, 1,230 amp; 1,500,000, cir. mils, 1,550 amp.

ALUMINUM FEEDER—A decidedly lower relative cost makes aluminum very advantageous for bare feeders alongside trolley wires or elsewhere. It has greater bulk, however, and consequently the advantages are largely offset by the increased insulation and jacket when used for high-voltage power cables or low-voltage trailing cables. But with bare feeder, aluminum has about 70% the current-carrying capacity of copper, and 3 ft of aluminum feeder can be bought for the price of 1 ft of copper.

Unit Resistance of Common Sizes of Copper Wire and Steel Rail

COPPER WIRE

Size, CM	Resistance, Ohms per 1,000 Ft
1,500,000	0.00719
1,200,000	0.00899
1,000,000	0.0108
750,000	0.0144
500,000	0.0216
300,000	0.0360
211,000	0.0509

STEEL RAIL

Weight	Equivalent Each Rail, CM of Copper	Resistance, Ohms per 1,000 Ft (both rails bonded and cross-bonded)
30	300,000	0.0180
40	400,000	0.0135
50	500,000	0.0108
60	600,000	0.0090
70	700,000	0.0077
80	800,000	0.0067
90	900,000	0.0060
100	1,000,000	0.0054

EDISON SYSTEM—One possible answer to the problem of keeping substation moves down while keeping voltage up is the three-wire, or Edison, system (*Coal Age*, July, 1947, p 86).

Sectionalization

Safety, quick isolation of fault areas, and quick replacement of damaged facilities are among the benefits of sectionalization. The latter applies particularly to the growing custom of using short lengths of cable with push-pull connectors in distribution of power at the face. Connector design is such that power is removed before the circuit is opened.

Recommended sectionalizing practice may be summarized as follows:

1. Provide in every instance sufficient capacity in the feeder and return so that the most remote dead short will open the overcurrent protective device, usually an automatic reclosing circuit breaker.

2. Install an overcurrent protective device in the circuit between each two substations at a point where resistance both ways is equal. If enough copper is used so that a ground at any point will open the protective devices at both substations, no intermediate protection is necessary. A section insulator, or "dead block," may be used between substations if they need not be paralleled.

3. Insert a disconnecting switch or protective device at intervals of not over 1,500 ft in all power lines.

4. Install an overcurrent-protective device in each circuit leaving a substation—fuses, or manual or automatic-reclosing circuit breakers. Circuit breakers should have trip-free operating mechanisms. The exception is where a substation feeds only one haulage unit, in which case only one station breaker is required.

5. Place an overcurrent protective device at each branch circuit.

6. Protect each circuit feeding a local section or territory with an overcurrent device.

7. Install overcurrent protection at the supply end of each circuit to pumps or other fixed loads.

8. Install switches to cut power off unimportant and infrequently used branch or stub circuits.

9. Protect each mining setup with an overcurrent device.

10. Keep overcurrent circuit-breaker settings or fuse ratings as low as practical for good operation. Specific settings are listed in a discussion of the subject in *Coal Age*, November, 1953, p 86. How to calculate load division as a guide to choosing breaker settings is detailed in *Coal Age*, August, 1955, p 55.

11. Cut power off all idle territories during non-operating times. If it is necessary to run a pump or some other one unit, special overload protection no greater than needed should be provided.

Ground Protection

The solid wire from machine frame to ground provides protection to men from short circuits—under most conditions—but no protection to the machine. Thus, some other provision is necessary. The original unit, still widely used, was the fuse, either in the junction or distribution box or in the trailing-cable nip. A major disadvantage is that a ground fault of low intensity, say 100 amp, is not sufficient to blow a fuse—or operate a circuit breaker—rated or set at 200 amp.

The best answer to this latter condition is a three-pole circuit breaker, with one pole in the grounding circuit equipped with a 5- or 10-amp current-limiting relay. A low-intensity fault will trip the breaker as a signal for corrective measures, while a high intensity fault will be cut off before severe equipment damage occurs.

Proposed alternatives, particularly for such mobile units as shuttle cars, include the polarized relay, the polarized short-circuiting device and certain electronic devices (*Coal Age*, February, 1955, p 84).

Guide to Better Stripping

Basic Approach

Sound planning based on engineering and operating studies of natural conditions, followed by selection and application of machines and methods to produce coal at the lowest cost possible.

Goals

Continuity of operation to keep unproductive moves to a minimum. Full-scale operation of all machines to get maximum production as well as full return on the capital investment.

Ways and Means

1. Lay the groundwork for effective mining by preparing adequate maps, prospecting, long-range planning of operations and selecting proper equipment.
2. Study drilling and blasting methods to choose the best technique for breaking overburden.
3. Examine methods of stripping, possible combinations of equipment and ways to get the most from equipment.
4. Match loading capacity with stripping capacity for effective overall balance.
5. Choose haulage equipment that will result in lowest ton-mile cost and at the same time match coal-loader capacity.
6. Buy power at highest possible voltage to reap benefits of most favorable contract. Plan the power distribution system so that equipment may be readily relocated and provide adequate protection for personnel and equipment.
7. Incorporate drainage plans in the basic stripping plan. Prevent inflow to pit as much as possible.

Laying the Groundwork

PROPERTY AND RESERVES—Two basic problems in developing a new strip mine are (1) putting together enough land and reserves to justify the capital expenditure for equipment, and (2) assembling reliable information about mining conditions and seams.

The type of stripping operation that can be planned depends to a great extent on the area and topography of the land that can be acquired for stripping. For example, the same equipment would not perform equally well in flat and mountain-areas. Furthermore, limited reserves of coal would not justify purchase of king-size equipment.

Regardless of the topography of the land and its area, it is extremely important to assemble as much information as possible about ownership, mining rights and going price per acre.

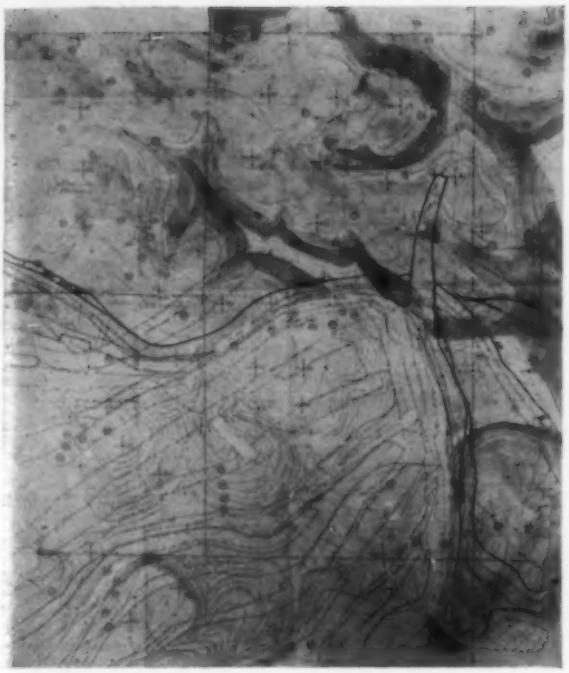
Information about the coal and the material covering it should be accumulated as quickly as possible as property is purchased or leased. Getting this information is an engineering job that includes topographic surveying, mapping and prospecting.

As rapidly as information is accumulated it should be recorded and analyzed. The numerous questions about mining rights, land ownership, coal thickness and quality, and thickness and type of overburden can be readily answered if all information is funneled to a central office and organized for ready reference.

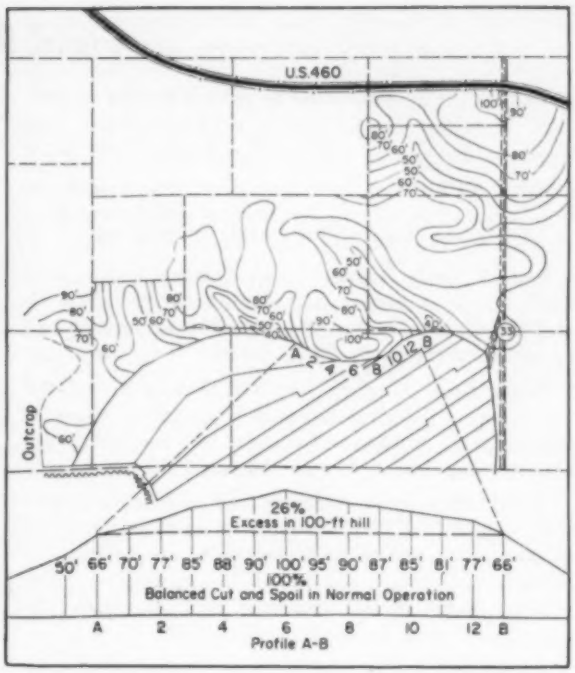
MAPPING THE LAND—Informative maps in the hands of competent engineers and operating supervisors are important tools in planning development, day to day operation and equipment moves. Modern methods make it possible to produce accurate maps in less than half the time required for ground surveys. And there is no sacrifice in accuracy.

With the aid of low-cost aerial maps, engineers can estimate coal reserves, plot property lines and coal outcrops, locate boreholes, lay out roads, locate spoil areas and calculate overburden ratios. The speed with which these maps can be made also makes it possible to use a monthly progress map to make an accurate, fast calculation of the number of cu yards of overburden and tons of coal removed, and direct stripping operation for the next month.

When it is not practicable to have an aerial survey made, a ground survey may be needed. The extent of this survey will depend on the topography and whether information is available in the form of government maps and geological bulletins.



ACCURATE MAPS are valuable in planning pit layout, spoil areas and day to day operation of stripping machines.


U.S.460
Outcrop
26%
Excess in 100-ft hill
50' 66' 70' 77' 85' 88' 90' 100' 95' 90' 87' 85' 81' 77' 66'
100%
Balanced Cut and Spoil in Normal Operation
A 2 4 6 8 10 12 B
Profile A-B

USEFUL PROFILE like this may be made from contour map to show excess material in cut beyond shovel range.

If deep mining was done in the area, mine maps on file with the State department of mines will provide a valuable source of information. They will show how close the old workings came to the outcrop and frequently show dip and thickness of the coal, and unusual geological conditions such as faults.

CHECKING THE COAL—As soon as basic maps are available, information about the coal seam and any conditions which might influence mine planning should be gathered. This information should be plotted on maps as it is accumulated. Drilling is the most satisfactory method of prospecting coal for full and accurate information. This can be done either by churn or diamond equipment. Diamond drilling provides a core section of the overlying rocks and the coal, and therefore yields very valuable information. A churn drill in the hands of a skillful operator also can provide accurate data but results depend on the skill of the drill operator. A coal core, on the other hand, can be examined visually and half of it sent to the laboratory for complete analysis. The other half can be kept for reference.

Several companies have found it helpful to photograph coal cores to provide a permanent graphic record of the core as well as to conserve storage space. The physical characteristics of the coal are frequently destroyed when a core is split and prepared for analysis. A photograph provides a permanent record of the appearance of the core.

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Property and reserves . . . Mapping the land . . . Checking the coal . . . Using the data . . . Planning reclamation . . . Studying markets . . . Locating the plant . . . Planning mine layout . . . Selecting equipment . . . Studying equipment ranges . . . Estimating mining cost . . . Moving cost . . . Balancing units . . . Radio communication

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Development of a bottom-discharge bit that prevents air circulation around the core has made possible the successful application of air core drills. Air coring is said to make possible 100% core recovery nearly every time, even when it is necessary to stop half way through a seam. A very important advantage of air coring is that thin, soft partings of clay or other material are not washed out as they would be when using water. Another advantage is that water lines and pumps are eliminated.

A new lightweight handheld diamond coring drill weighing only 45 lb is available for prospecting under as much as

Field Reports

Large Coal Haulers—New large coal haulers in two-shift operation carry more coal with greater fuel economy than smaller units. Coal Age, July, 1958, p 74.

Better Drill Cuts Cost—Improved vertical overburden drill serving two pits slashes drilling cost by one-third in thick, tough rock. *Coal Age*, July, 1958, p 92.

Special Truck Delivers Clean Lubricants—A special truck travels around an Alabama pit and transfers oils and greases directly from the original containers to machines. *Coal Age*, July, 1958, p 120.

Better Boom Supports For Big Shovels—Strands replace wire rope after thorough engineering study of boom-support problem. Attachment to boom and gantry also are simplified. *Coal Age*, August, 1958, p 96.

Aerial Mapping—Low-cost aerial photography provides a basic tool in cost control at an Ohio operation. Maps prove useful in land evaluation, purchasing, cost control, laying out roads and communication lines, plotting boreholes and estimating coal and timber reserves. *Coal Age*, September, 1958, p 112.

Anthracite Company Modernizes—A new walking dragline with a 200-ft boom and 32-yd bucket sets the pace in a modernization program that extends the company's range of operations. Other new units boosting efficiency are two vertical dry-type drills, a 6-yd rubber-tired front-end loader and an 8-yd benching dragline. *Coal Age*, October, 1958, p 100.

Blow Charging Ammonium Nitrate—Greater loading density and a significant saving in time and effort in charging horizontal blastholes are two possibilities with use of a blow-charging machine. Experiments at an Ohio mine show that an 80-lb bag of ammonium nitrate can be mixed with 1 gal of fuel oil in 20 sec and then blown into a horizontal hole in 10 sec. *Coal Age*, November, 1958, p 86.

Bulk Handling of Ammonium Nitrate—By using a bulk loader a western construction company is able to load 200 to 300 lb. of nitrate-oil mixture in 20 sec. Another western company solved the nitrate-handling problem by developing and air-loading procedure. *Coal Age*, November, 1958, p 104.

Blasting Agent Packed Faster—The first commercial bagger for packing explosives is in service in Illinois. The company uses the device to pack its own explosive either in bags or tin cans. *Coal Age*, November, 1958, p 130.

Scrapers Key Flexibility at 2,500-tpd Mine—Ripper-equipped tractors precede wheeled tractors pulling 25-cu yd scrapers in removing up to 2,000 cu yd per hour of overburden in Ohio. Scraper stripping provides flexible operation and offers advantage of faster moves to new areas. *Coal Age*, December, 1958, p 110.

Stripping Adds 1,100 tpd to Company's Output—Purchase of a new vertical overburden drill and change to ammonium-nitrate-type blasting agent cut blasting cost. Better fragmentation enables 3½- and 4½-yd stripping units to dig easier. *Coal Age*, December, 1958, p. 84.

Digging Deeper at Lower Cost—A bulldozer with hydraulic ripper and a diesel-powered benching shovel increase flexibility in operation for a company employing draglines as major stripping units in two pits. *Coal Age*, January, 1959, p 82.

Amphibious Pump Carrier Simplifies Pit Dewatering—To simplify installation and movement from pit to pit, a Kentucky operator mounts pumps on amphibious trailers which travel equally well on land or water. *Coal Age*, January, 1959, p 118.

Dozer Converted to Pumper—An old bulldozer serves as a permanent carrier for a large centrifugal pump which is used to remove water from isolated drainage sumps. *Coal Age*, January, 1959, p 118.

New Alloy Steel For Lower Strip Maintenance—Increased machinery capacity and greater service life result from application of high-strength alloy at an Ohio operation. *Coal Age*, February, 1959, p 126.

Strip Mine Engineering For Big Shovels—Good pit design and informative operating maps are among the most important elements in stripping with 70-yd shovels. *Coal Age*, March, 1959, p 98.

Stripping and Augering—Bulldozers and draglines remove overburden in two-seam stripping in hilly terrain. The key-cut principle, cleaning holes before charging and use of special primers and delays result in overall reduction in blasting cost. *Coal Age*, April, 1959, p 84.

Efficient Thin-Seam Stripping—A 30-yd shovel moving 900,000 cu yd per month sets the production pace at a Missouri mine recovering 4,000 tpd from a 26-in seam. *Coal Age*, May, 1959, p 80.

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200 ft of cover. In shallow drilling the unit recovers up to an 8-in core and in deeper drilling it recovers a 5⅛-in core. One man can operate it on 2 to 2½ gal of fuel per day.

Diamond drilling results have been improved by perfection of the wire-line coring technique for coal prospecting. The wire-line coring method differs from the conventional method in that a retractable inner tube is used. At the end of each run, the core-laden inner-tube assembly is hoisted to the surface through the drill string, as opposed to the conventional method wherein it is necessary to pull the entire string and core barrel to recover the core. Increased coal recovery, lower diamond cost and saving in drilling time are advantages of the method.

A quick, easy and inexpensive method of determining the consolidation of overburden in strip operations has been developed. The new process, called seismic analysis is based on the principle that sound or shock waves travel through different subsurface materials at varying speeds and along different paths. By this method the operaor can determine whether overburden can be ripped or whether it will need to be drilled and blasted. Two men, after a minimum of training, can perform a seismic study in a matter of hours.

If the coal bed outcrops, prospecting should be done at regular intervals along the outcrop. The modern tool for this job is the bulldozer. Once the bulldozer is on the outcrop, it can make an opening faster and more economically than by hand methods. Outcrop openings and trenches extending above the coal

bed, can yield other useful information on the type and nature of the rock covering the coal and how much outcrop coal must be removed before merchantable coal is reached.

USING THE DATA—In any prospecting program, sufficient holes should be drilled or outcrop openings made to get an accurate picture of the coal and overburden. Prospecting results including seam thickness and elevation, should be plotted on special maps as quickly as possible. This information then should be used to construct coal-thickness contours as well as contours of the top of the coal. These two sets of contours along with surface-contour maps are useful in computing overburden ratios and planning stripping methods. Coal-thickness contours are especially helpful in planning operations when the coal bed is not uniform in thickness.

PLANNING RECLAMATION—Two problems demanding more and more attention are: (1) restoring spoil areas to usefulness after mining is completed and (2) preventing stream pollution. The type of restoration work depends on such factors as contour of the land, type of overburden as well as State regulations. Someimes the only immediate steps that can be taken after completing stripping are backfilling and leveling because the spoil will not support plant life until it has decomposed by weathering for several years. In any event the material in the spoil bank should be analyzed to see if it will support plant life before planting is begun.

STUDYING MARKETS—A study of today's market as well as tomorrow's possibilities will serve as a guide in planning mining methods as well as selecting and designing preparation facilities. For example, the type of preparation facilities demanded for preparing a steam coal would probably not be the same as those required in processing metallurgical coal. Furthermore, overburden preparation methods and coal loading procedures could be influenced by market requirements.

LOCATING THE PLANT—A number of factors govern the choice of a plant site. Among these are topography, access to rail or water transportation, sufficient building area and distance to the coal to be mined. If wet-washing facilities are to be included in the plant, a reliable water supply will be important, along with room for thickeners or sludge ponds. Refuse-disposal area also must be considered in choosing a plant site.

PLANNING MINE LAYOUT—As soon as the preparation plant site is chosen the most advantageous point to open the strip pit should be selected. Then a permanent haulage road connecting the pit with the preparation plant should be laid out. Time and money can be saved by laying out a preliminary road on a topographic map and then making estimates of the earthwork required to make the road. By making this preliminary layout field work will be cut down to such items as marking road alignment, setting grade stakes and making minor adjustments.

Good road alignment and good grades pay off in faster haulage and lower truck maintenance. A solid, well drained roadbed enables trucks to travel at the top recommended speed and keeps wear and tear to a minimum.

The method of attacking the coal is governed by a combination of the following factors: type, thickness and contour of the overburden; thickness, quality and area of coal available. If the coal bed does not outcrop, a box cut will be needed to open the pit. If the coal outcrops a considerable distance above drainage and contour mining is planned, it may be necessary to spend a great deal of money to provide a solid, all-weather road to the coal level. Sometimes it may prove more economical to build a bin, feeder and conveyor to haul coal downhill to the preparation plant and restrict truck haulage to nearly level roads along the outcrop. Whatever the choice of transportation system, the goal is the most economical system possible.

SELECTING EQUIPMENT—Topography, coal reserves, expected selling price of the coal, type of overburden, spoil area and tonnage of coal desired per shift are some of the major factors influencing the selection of equipment. Since other machines should be matched to stripping capacity, the selection of the stripping unit will influence the choice of the other machines.

The capacity of a stripping unit will be influenced considerably by the estimated number of cubic yards of overburden that can be removed to recover a ton of coal. Once the economic limit is established the stripping unit can be selected.

STUDYING EQUIPMENT RANGES—Profiles or cross sections of the proposed stripping area along with key equipment dimensions and ranges are valuable in selecting the machine or combination of machines best suited to the conditions. This type of diagram will show how wide the pit can be made, what the spoil area will look like and how each machine can be used most effectively.

Consider the needs of a specific mine in relation to overall efficiency and cost rather than in terms of dirt-moving capacity only. Continuing growth in size and earth-moving ability of new and bigger machines are the result of the industry's demand for these machines. But there also still remains the need for medium and smaller size shovels and draglines.

ESTIMATING MINING COST—An estimated mining cost based on engineering studies is the best guide in determining the economic stripping limit. The estimated figure should include a complete breakdown similar to the accounting method that will be followed when the mine is in operation. For example, labor and material costs should be estimated for such items as drilling, shooting, stripping, explosives, pit cleaning, coal loading, haulage, road building, fuel, oil, grease, maintenance, supervision, depreciation and any other items needed to build up the estimated cost as accurately as possible.

MOVING COST—First cost is not the only expense involved with a stripping machine. It must be erected on the job and perhaps torn down and moved to a new site. Mounting labor costs must be given careful thought in the moving and erection costs of equipment. These two indirect costs alone may set an economic limit to the size of the unit because it is not always possible to amortize equipment during the life of an operation. Where it is not feasible to do this, medium and smaller size machines have the added advantage of low-cost moving to another location.

If the acreage or reserves of mineable coal is not large enough to justify the purchase of a large dragline or shovel, the ability to move a unit to a new site becomes an important factor in equipment selection. Mobility of equipment is particularly desirable for small or medium size companies in acquiring new coal reserves, especially in areas where large strip reserves no longer are available.

BALANCING UNITS—Once the capacity of a mine has been decided and the major stripping machine chosen, other units, such as drills, coal shovels and trucks should be selected to build a balanced production cycle. After the production cycle is established, any change in one of the cycle components will upset the balance. Unless other changes are made, inefficiency will result.

It is sometimes practicable as well as economical to add flexibility to the operation by adding a small or medium size shovel or dragline. For example, a small machine sometimes can be used profitably to remove cover in a tandem operation where a large shovel or dragline

MECHANICAL TAMPING of blastholes conserves manpower, increases flexibility. Tamping rod is spooled on square reel.

HORIZONTAL ROTARY DRILL has features of vertical dry-type machines. Unit drills 48 ft deep with one drill stem.

takes the major portion of the overburden.

RADIO COMMUNICATION—Where mining plans call for the various machines to be working far apart or in more than one pit a radio communication system is valuable. Money spent on the radio setup frequently can be repaid in better supervision and less equipment downtime. For example, equipment downtime can be substantially reduced because stripping units can report trouble immediately. Thus repair crews and facilities can be called to the scene promptly. If the job requires parts or materials not on hand, they can be ordered from the warehouse in a matter of seconds merely by picking up the microphone and calling. If an emergency order for a part must be sent to the factory, word can be sent to the mine office and immediately relayed by phone to the factory. Frequently the part can be on the way to the mine by plane in less time than it would take to drive from the pit to the office to telephone.

Another important benefit of radio communication is that supervisory efficiency can be improved considerably by reducing the time needed to cover the ground to check operations. With radio, much of the routine of checking on the progress of stripping and pit conditions can be done by calling the pit, thus reducing supervisory driving to a minimum and leaving more time for planning.

Overburden Preparation

THE AIM in overburden preparation is to get the best fragmentation possible while keeping drilling and blasting cost within economic limits. Benefits of maximum fragmentation for easy digging must be weighed against increased costs for drilling and blasting.

HIGH-CAPACITY DRILLING — Large-diameter blastholes, up to 12 in, sunk by vertical rotary dry-type machines offer the following advantages: ability to concentrate explosives in the hard layers; opportunity to use low-cost make-your-own blasting agents; and fewer holes to break a given volume of overburden.

Vertical rotary machines have drilled 1,000 ft of 10¾-in hole (*Coal Age*, March, 1953, p 80), and 1,200 ft of 6¼-in hole in a single shift (*Coal Age*, February, 1957, p 98).

When difficulty is experienced with the hole squeezing together in the portion drilled through clay or soil with a rotary vertical unit, it can be overcome by augering through the soft material and then changing to the regular roller bit. Although this requires two extra tool changes, the faster penetration of the soft material and the elimination of trouble resulting from squeezing will pay. At one Illinois operation this method of drilling resulted in a savings of $8,000 per year in bit cost.

At some mines auger stems are being used successfully with rotary dry-type machines to help bring the cuttings to the surface.

Another dry rotary unit in the crawler-mounted group cuts its own drill road and also has a built-in water-spray system to suppress fine drill dust (*Coal Age*, June, 1957, p 60).

> An improved high-capacity rotary dry-type vertical drill serving two pits slashed drilling cost by one-third in thick, tough rock.

The unit does in 16 hr per day and one day less per week the work that formerly require around-the-clock operation 7 days a week. (*Coal Age*, July, 1958, p 92).

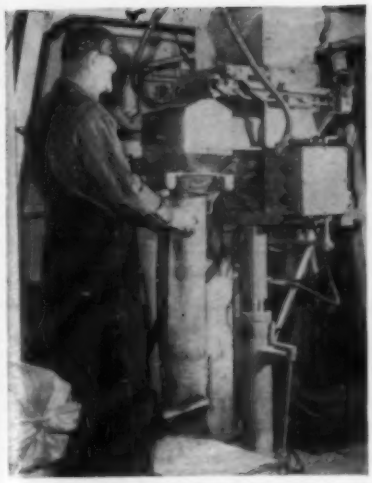
MOBILE DRILLS—Smaller, lighter, more mobile and less expensive vertical drills provide efficient units for operations producing up to 2,000 tpd. These smaller machines include both truck- and crawler-mounted designs and can be readily moved from place to place to serve two or more pits.

VERTICAL AUGERING—Vertical augering machines have been improved to the point where they can drill a 9-in hole in coarse-grained sandstone to a depth of 100 ft. Operating through a multispeed transmission, drill rotation can be regulated according to the toughness of the rock. Up to 600 ft of hole per shift can be drilled with this machine.

At one Ohio mine two crews use auger-type machines to sink an average of 600 ft of hole each per shift in sandstone overburden (*Coal Age*, July, 1957, p 60).

A down-the-hole rotary percussion drill, working three shifts in an anthracite pit, sinks enough holes in hard rock to keep pace with 6- and 8-yd draglines. Water check valves between two of the drill rods prevent entry of water and dirt into the hammer if the compressed-air supply is interrupted in the drilling of wet holes (*Coal Age*, May, 1958, p 114).

HORIZONTAL AUGERING — The horizontal sidewall drill remains a favorite for special applications and where the cover is comparatively thin, or where tough rock lies close to the coal. In some cases they are used effectively for two-



BAG-PACKING MACHINE speeds packaging of make-your-own blasting agent.

BLOW CHARGING of horizontal blast holes offers advantages of faster, denser loading of ammonium nitrate-oil mixture, plus lower-cost tamping of charges.

level drilling in thicker cover. Special adjustable-level hydraulically powered sidewall units can be used effectively to drill near a strata whose position over the coal varies up and down. They also have the advantage of easy leveling in an uneven pit.

HORIZONTAL ROTARY DRILLING—To meet the need for more efficient equipment to drill hard rock fast, a horizontal rotary dry-type overburden drill now is available. One of these machines in service at an Indiana mine drills a 9-in hole 48 ft deep without adding drill sections. Penetration is 50 in per minute. Working one full and one part shift six days a week, it drills enough holes to prepare overburden for round-the-clock operation, seven days a week, of a 40-cu yd shovel. In the best single shift, 816 ft of 9-in hole was drilled by one man. Clean, smooth holes make possible loading of explosives with diameters only slightly less than the hole. Holes are reported to be straight and not to drift in the direction of rotation as auger-drilled holes do. Drill cuttings, as with vertical dry-type machines, make excellent stemming material (*Coal Age*, October, 1957, p 98).

SPECIAL DRILLS—Special units have been developed to drill thin layers of hard rock over the coal when the major portion of the overburden can be dug without blasting or to drill an interval between two seams. One four-unit jumbo machine mounted on a tractor drills 2-in holes on 6-ft centers and has capacity to keep pace with a 42-yd shovel that strips the main cover. (*Coal Age*, October, 1956, p 60).

A tough drilling problem in the Corby area of England was solved by mounting a horizontal drill on a shovel boom so holes could be placed in sandstone 15 ft or more above the base of the overburden (*Coal Age*, January, 1958, p 136).

Breaking Rock

CONSTANT STUDY of the overburden and the field results obtained with explosives are basic to good blasting. Since good bank preparation depends on placing the righ texplosive in the right place, and since conditions usually are constantly changing, blasting methods must be flexible.

Sometimes a particular type of rock can be broken best with a heavy charge in large-diameter holes spaced far apart. In other cases, smaller holes spaced closer together will provide better breakage. A combination of vertical and horizontal holes produces the best results at other times.

In selecting the right explosive for a job, engineers and operators must consider the physical characteristics of the bank, the drilling equipment available and the digging equipment to be used.

BLASTING MEDIUMS—Blasting mediums in use today include various types of high explosives; liquid oxygen; and newly developed lower-cost ammonium-nitrate-type blasting agents.

Many of the explosive manufacturers now are producing ammonium-nitrate-type or similar blasting agents. Some of these agents include the following: (1) Nitro-carbonitrate which contains technical-grade ammonium nitrate instead of commercial grade. It is not cap-sensitive, and therefore a primer must be used to set off. Speed is about 11,500 fps; (2) Unimite and (3) Methanite which contain technical-grade ammonium nitrate, coal dust and nitromethane. The nitromethane acts as a sensitizer for the ammonium nitrate and under certain conditions it is not necessary to use a primer. Speed is about 13,000 fps.

Significant improvements in manufacturing techniques have resulted in lower prices for liquid-oxygen explosives. Having a speed of 17,000 fps, this explosive has been very useful in breaking high banks containing massive sandstone.

NITRATE-OIL MIXING—The most popular of the make-your-own group of blasting agents is made by mixing No. 2 fuel oil with either prilled or grained ammonium nitrate. Approximately 3 qt of fuel oil are added to each 100 lb of ammonium nitrate. Sometimes the oil is added in a mixing plant and the product put up in bags. Some operators say that the oil should have time to penetrate the ammonium nitrate and therefore let the bagged oil-nitrate mixture season. The seasoning period varies from several hours to several days.

Other companies add oil directly to the opened original bags of nitrate at the hole site. The oil percolates down through the nitrate and the mixture is poured from the bag into the hole.

A recent development with ammonium nitrate and fuel oil mixtures is to use a heavier and more viscous oil having a higher heat content. The heavier oil is less volatile and does not soak into or through containers. Because of the increase in available energy, blasting results are improved. But to get the better results, it is necessary to use a mixer rather than hand methods to blend the ingredients.

There is a trend toward using grained ammonium nitrate because it provides a blasting agent with 20% to 30% greater density and thus makes possible greater concentration of the agent in drillholes. The velocity of the mixture also is 1,000 to 2,000 fps greater with heavier oil.

BULK LOADER for vertical holes delivers ammonium-nitrate-oil mixture at rates up to 300 lb in 20 sec.

MECHANICAL MIXING of nitrate and oil during gravity loading is achieved with aid of electrical controls.

DRY HOLES receive oil-treated ammonium nitrate prills directly from bags.

DAMP HOLES are loaded with nitrate-oil mixture packed in polyethylene bags.

WET HOLES are loaded with explosive packaged in water-resistant cartridges.

How one operator varies hole-charging methods to meet changing conditions

Some operators now are using a combination of grained ammonium nitrate for loading the bottom of holes and prilled nitrate for the top. This method of loading makes possible wider hole spacing and a corresponding saving in drilling.

A superior blasting system employing a mixture of oil and prilled clay-coated ammonium nitrate was developed by an Ohio operator. The system consists of using prills coated with 0.4% of anticaking agent and two different percentages of oil. The two oil mixtures are: a 2% mixture for maximum sensitivity in the priming charge and 6% in the main charge. The company wraps 60-grain detonation fuse six times around the bag of priming charge to impart a high rate of detonation to the main charge (*Coal Age*, June, 1958, p 128).

NON-SENSITIVE PRIMERS—Non-nitroglycerine primers for use with make-your-own blasting agents are growing in favor. These primers are popular because they cannot be detonated if a shovel digs into a misfire. Danger to personnel and equipment from this hazard thus is eliminated. A popular unit combining safety and economy is a 5-lb primer packaged in a polyethylene bag.

LOADING HORIZONTAL HOLES—When the overburden is not too thick or is not exceptionally hard, a single row of properly charged horizontal holes usually is sufficient to break the overburden. The rule of thumb in blasting with a single row of horizontal holes is to space them so that the resistance of the material above the holes will roughly equal the resistance of the material between the holes.

If the horizontal holes are placed too close together, the explosives will have a tendency to shear between holes rather than exert force upward to break the rock. As the thickness of the overburden increases, it becomes necessary to increase the hole diameter to maintain the proper concentration of explosives and not get shearing. In thicker cover it is possible to use angled holes or a combination of horizontal and vertical holes.

BLOW CHARGING—Greater loading density and a significant saving in time and effort in charging horizontal blastholes are two major benefits resulting from the use of a blow-charging machine. Experiments at an Ohio mine show that an 80-lb bag of ammonium nitrate can be mixed with 1 gal of fuel oil in 20 sec and then blown into a horizontal hole in 10 sec (*Coal Age*, November, 1958, p 86).

At a West Virginia operation pre-oiled ammonium nitrate, half prilled and half granular is purchased in 80-lb bags and

SHOOTING WATER out of holes makes possible use of make-your-own explosive.

blown into horizontal holes by a truck-mounted unit. It takes about 3 min to blow 240 lb of nitrate into a hole. Each hole is primed full length of the charge with 1¼x12-in high-velocity gelatin inserted in connected sections of tubes.

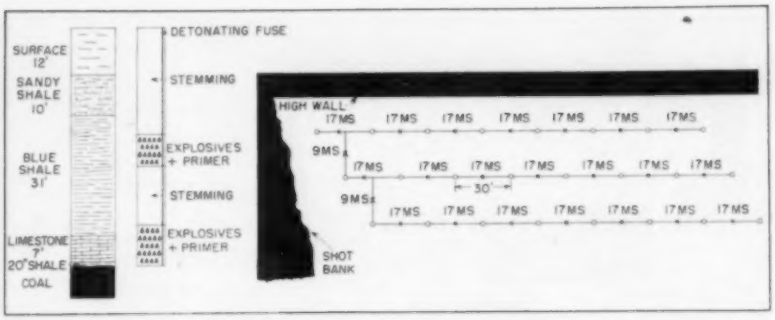
MECHANICAL TAMPING—Another device designed to reduce human effort in loading and tamping horizontal holes is the load-tamp machine. With the aid of this unit, one man in four days, single shift, does what it took two men five and six days to do. Greater flexibility in pit operations is an added benefit since blastholes now can be loaded after the seam is taken out to the highwall.

The operator's duties consist of placing the explosives and tamping bags in the collar of the hole. Using prefilled tamping bags, one man has loaded and tamped a maximum of 28 holes in a shift (*Coal Age*, September, 1957, p 88).

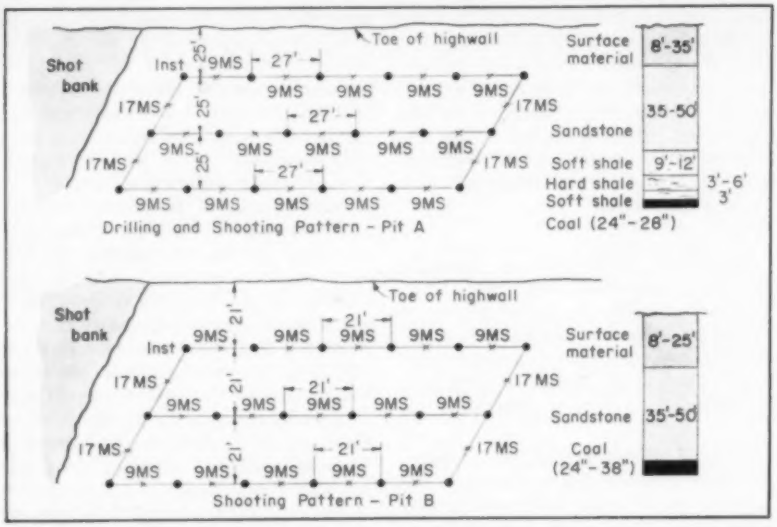
BULK LOADING—Bulk handling procedures are cutting handling costs of make-your-own blasting agents at several mines. One bulk loader for vertical holes consists of a storage hopper, hoist, air compressor, oil-storage tank and a measuring dispenser, all mounted on a flat-bed truck which is loaded from a 36-ton bin.

An air motor run by the compressor and a winch in the fore end of the truck is used for tilting the hopper to enable the nitrate to gravity feed into a 300-lb measuring container at the back end of the truck. The nitrate is admitted to the borehole by opening a butterfly valve in a 6-in drain pipe.

Actuation of the manually operated valve also operates a snap valve on an oil line through a mechanical linkage to spray a metered quantity of oil through a nozzle in the drain pipe onto the nitrate as it falls through the pipe. A drill hole can be loaded with 200 to 300 lb of mixture in 20 sec.



DECK LOADING is advantageous in overburden consisting of rocks with varying hardnesses. Millisecond delays increase the effectiveness of explosives.



DRILLING AND SHOOTING procedures in tough rock are designed to get maximum fragmentation at lowest cost. Delays improve shooting results.

Another company developed a mechanical mixing system for bulk loading vertical holes. The proper mixture of oil and nitrate is obtained by controlling the gravity flow of nitrate out of a hopper and by metering oil as it is sprayed into the falling nitrate stream.

A third company solved the handling problem by developing an air-loading procedure for charging holes angled upward at 45 deg. Ammonium nitrate is poured into the storage hopper of the loading device, from which it is admitted to an air tank. As air at 35 psi moves the nitrate through a rubber hose, fuel oil is forced by air through an adjacent hose. The two meet at a junction point and flow through a pipe into the drillhole at the rate of 100 lb in 100 sec (*Coal Age*, November, 1958, p 105).

CHARGING WET HOLES—Two problems to overcome in charging wet holes with ammonium-nitrate-type blasting agents are: (1) protecting the mixture from moisture and (2) obtaining a mixture of nitrate with the proper density so it will sink in the water.

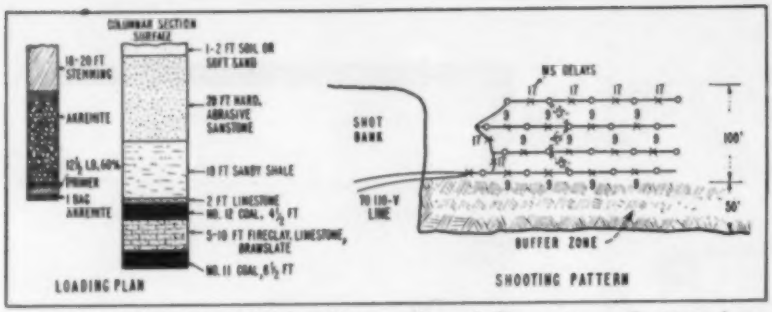
An Ohio company solved these two problems by packaging the blasting agent in burlap bags with a polyethylene liner and using ground granules with prills to get a density of 1.16.

The mixture for wet holes, mechanically mixed in 2,000-lb lots at the company's plant, consists of 1,360 lb of prilled ammonium nitrate with a density of 0.95, 640 lb of ground ammonium nitrate granules and 85 lb of No. 2 fuel oil. Bags are filled at the plant by hand vibrating.

One-third pound of cast PETN is used as primer for each 192 lb of the ammonium nitrate mixture. It is placed inside a bag of nitrate mixture and connected to the 60-grain detonating-fuse trunk line by a short section of detonating fuse.

Several companies have found it profitable to shoot water from wet holes with explosives. For example, one company uses approximately 1 lb of PETN with cap per 5 ft of water. All holes to be shot are prepared before any one hole is shot, then the holes are fired separately.

Each hole is inspected for depth of new water before loading. If no more



BUFFER SHOOTING makes possible a uniform drilling pattern, eliminates large chunks that are sometimes produced when shooting against an open face.

than 6 in of water returns to the hole, the oil-nitrate mixture is poured into the hole. If more than 6 in of water returns, cartridge powder is used up to a level above the displaced water, and then ammonium nitrate is added in the remainder of the hole. A second operation uses 4 to 8 lb of 60% dynamite per hole to blow out water.

BUILT-IN PRIMERS — Specially packaged ammonium nitrate with built-in primer simplifies loading of horizontal blastholes while maintaining the advantage of low cost. These packages commonly come in 20- and 25-lb cylindrical cartridges, 4 or 5 in in diameter.

DELAY SHOOTING—Delay shooting usually will enable explosives to do a better job. At many mines milli-second delays have been used successfully to get better fragmentation and at the same time reduce concussion in the surrounding area. Reduction of vibration is especially important where stripping is being done near populated areas.

As overburden becomes thicker, the problem of vibration and shock becomes greater because the thicker rock requires more explosives. In recent years, the MS-delay connector has become a valuable tool in reducing vibration—in many instances to about 25% of that with the usual shot.

The MS connector essentially is a piece of detonating fuse with a millisecond delay built into the center. Benefits from the connectors include setting off a greater number of holes per shot with less vibration, and elimination of the hazard involved in loading a cased hole where it is necessary to charge from the drilling machine through the casing and then pull the casing up over the shunted cap wires. During this operation there is always the hazard of stray currents or a short circuit that might ground through a damaged cap wire, setting off the charge. With detonating fuse, no cap is used until this operation is completed and the machine has moved away.

A further advantage includes a 15% speedup in the detonation of the explosive with a reduction in the requirements. Fragmentation is as good and probably better with the rdeuced charge. Digging into misfires is not likely to result in an accidental explosion since caps are not used.

While many applications have resulted from the use of detonating fuse and MS connectors, at least one serious disadvantage of the combination is the noise and concussion caused by the detonation of the unconfined trunk line. When the shooting operation is close to populated areas, this condition presents a problem. At one mine where the elimination of noise is highly desirable, detonating fuse is used to fire the primers. Holes are shot in groups of 11, using a single instantaneous electric blasting cap and delay caps in series 1 through 10. Only a single shovelful of dirt is required at each hole to effectively cover the few inches of exposed detonating fuse and the blasting cap.

BUFFER SHOOTING—There are certain advantages to shooting against a buffer were vertical drilling is practiced. Large chunks of rock, sometimes produced when shooting against an open face are eliminated. The long toe that cannot be shot at all is eliminated. The drill never is required to work close to the highwall in an attempt to shoot a toe. A uniform pattern of drilling can be maintained because regardless of how crooked a pit is when first opened, adjustments can be made to produce a straight pit with a minimum of trouble.

Once a sufficient buffer is established to put the drill well ahead of the stripping machine, other benefits are possible. For example, in periods of dry weather the drill can be worked in areas of the highwall that would be very muddy in wet weather. And in wet weather the drill can be worked on ridges or high spots. If advance preparation of the highwall is needed for moving the drill, felled timber and brush can be pushed on to the buffer area and require no rehandling prior to final disposal.

The operation of the stripping unit can widen or narrow the pit to take full advantage of the machine in the spoil area available and without interfering with the drilling and shooting. Better slopes of the highwall can be made, thereby eliminating many slides that occur when there is a high, cracked over-hang.

IMPACT BREAKING—At a western Kentucky mine recovering two 5-ft seams of coal separated by 11 ft of rock an unusual method of breaking the interval is used. The outer 25 ft of a 45-ft cut is broken with a 17-ton drop ball. The breaking medium actually is a steel billet 8 ft. long, 60 in wide and 30 in thick. It is hoisted 50 ft into the air by a diesel-electric shovel converted to a crane and dropped on 6-ft centers. Cycle time is 45 sec. Excellent fragmentation is reported at a considerable saving over drilling and blasting.

BLASTING RECORDS—Good records should be kept for all blasts, including depth and spacing of holes, quantity and distribution of explosives per hole, type and thickness of overburden, feet of drilling, and cubic yards of material broken each day. When a satisfactory plan for shooting is worked out it should be adhered to until conditions change.

One company has developed an electric device that automatically records the depth of the blasthole as it is drilled. When a change of strata or a significant change in hardness occurs in the rock, it is reflected in a variation in drilling pressure. The drill operator notes depth on the indicator, as well as pressure, and records both in a log book. The record for each hole is given to the blaster to serve as a guide in charging the holes (*Coal Age*, May, 1955, p 122). The blaster can look at the hole log, tell how tough the rock is and then determine how much explosives will have to be used to get the best results. Drill-pressure indicators also show changes in the hardness of the strata and thus provide additional data for judging placement and quantity of charges.

Stripping

REMOVING OVERBURDEN as economically as possible is the aim with any stripping machine. To move the maximum volume of material, a machine not only must operate continuously but also must make each motion perform useful work.

SHOVELS AND DRAGLINES — Shovels are available in a wide range of designs and capacities to meet most stripping conditions. For example, a 3-cu yd shovel with a 28-ft boom and

SUBSTANTIAL SAVINGS over drilling and blasting costs are sometimes possible with hydraulically-controlled rippers.

SCRAPERS, push-loaded by big bulldozers, are effective in cutting down overburden loosened by ripping.

20-ft dipper handle can cut to a 32-ft height. A 45-yd shovel with a 120 ft boom and 79-ft dipper handle can cut to a height of 107 ft. The 60-yd shovel which went into service in 1956 has a 150-ft boom and can pile spoil 97 ft high. The 70-yd shovel which began stripping in 1957 has a 140-ft boom and a maximum dumping height of 96 ft 6 in.

Draglines also are available in a wide range of sizes to meet varying conditions. A 2¾-yd dragline with a 110-ft boom can dig to a depth of 58 ft and spoil to height of 49 ft above the bottom of the bench on which it is working. A 35-yd unit with a 220-ft boom can dig to a depth of 94 ft and pile spoil 98 ft high above the tub. In between these sizes are a host of machines that can handle nearly any assignment.

Big shovels in the 33- to 70-yd range usually work to a maximum of 70 or 80 ft of cover. Removal of overburden between 9 and 50 ft thick by a 45-yd shovel costs about 45% of what it would cost to do the same job with an 8-yd shovel; in overburden between 9 to 90 ft, about 77% of the cost with an 8-yd shovel and in overburden between 50 and 80 ft, about 25% more than an 8-yd shovel working in a bank 50 ft high. Big shovels also recover coal that would be left by smaller shovels or would have to be augered or deep mined. But the area to be stripped must contain enough coal to warrant the capital expenditure for a big shovel.

Flat coal seams and steep slopes cause overburden thickness to increase rapidly as successive cuts advance into the hillside. To meet these difficult conditions, the large walking dragline is most useful because of its long dumping range. The stripping life is increased in proportion to the dumping range of the dragline, and maneuverability of the unit is advantageous in working sharp angles and inside curves. The disadvantage is that it must have a suitable base and this is sometimes difficult to provide in rocky overburden. This factor must be considered in choosing between a dragline and shovel.

BULLDOZER-SHOVEL STRIPPING —A possible combination for stripping up to 35 ft of softer material is the small shovel and the bulldozer. With this type of setup the bulldozer works across the outcrop and takes off 10 to 12 ft of loose material—sometimes up to 20 ft. (*Coal Age*, January, 1954, p 82). The shovel is used to remove the more solid material down to the top of the coal.

At another operation in Pennsylvania two big, powerful bulldozers are teamed with a diesel-powered 2-cu yd shovel and a 4-cu yd diesel dragline to move up to 60 ft of cover (*Coal Age*, March 1957, p 82). Each dozer works with one of the strip machines in a separate pit, two shifts per day. The bulldozers not only cut down a portion of the bank but also push a great deal of the material into the pit where the stripping units can handle it easier. They also push a large portion of the material in the spoil to a point beyond the range of the stripping units.

After a sufficient area of coal is uncovered, the shovel doubles as a coal-loading unit while the bulldozer continues to remove the top layer of cover or performs utility work. The shovel-bulldozer setup is not designed for high output but can be used effectively where cover is relatively soft and a large capital expenditure is not feasible.

SCRAPER STRIPPING — Conditions may change after a stripping unit has been purchased and it may be desirable to go to a higher bank. But the available shovel or dragline may not be able to handle the overburden in one pass. Consequently, rehandling or two passes are needed. Or the unforeseen problem of a shortage of spoil area may develop and partial haulage may be necessary. Under these conditions the high-speed rubber-tired tractor-scraper has gained acceptance as an efficient auxiliary machine to move the top portion. Once loaded, the unit can haul spoil several hundred feet at little added cost. If the overburden is compacted, it is good practice to supplement the scraper units with a ripper that can be taken over the area ahead of the scrapers to break up the ground.

Scrapers, push-loaded by big bulldozers, slice off overburden in 25-cu yd bites at an eastern Ohio operation. Six units remove 1,800 to 2,000 cu yd per hour while working banks 50 to 60 ft high. Ripper-equipped tractors precede the scrapers to break the friable sandstone for the scrapers (*Coal Age*, December, 1958, p 110).

Tractor-scraper units also can be used to make an opening cut and working bench for a dragline. The number of tractor-scrapers needed for the job depends on how much of the total cover can be moved by the scraper and how much overburden must be moved to uncover the coal needed each day. For example, five tractor-scraper units aided by a rooter have removed 30 to 35 ft of cover at an operation working to a 75-ft highwall and producing 1,700 tpd of strip coal. Shovels remove the lower portion of the overburden.

A worthwhile advantage of the scraper method of handling spoil is that little extra work is necessary where backfilling and leveling are required.

In some present day deep anthracite pits where available draglines cannot handle overburden in one pass, the high-speed scraper has been well accepted as a primary unit in removing the top layer of overburden. Thus the dragline burden is eased.

A push-loaded scraper will load faster and will carry greater payloads because

the load is heaped better and packed tighter. To get the most from scrapers, the loading area should be planned so that the units load on a down grade; haul roads should be well maintained; and the dumping area kept in good condition so the load can be released while traveling at a fair rate of speed.

Good preventive maintenance practices to follow in scraper operation include keeping good cutting edges on the scraper at all times; and holding the apron at proper height while loading to avoid damage or distortion. A misshaped apron permits load leakage on to the haul road with possible resultant tire damage. A light channel welded across the top of the scraper front end will prevent the sides from bulging and will not hinder loading.

RIPPING OVERBURDEN – The development of the hydraulically operated ripper mounted on the rear of a large bulldozer has increased the range of the scraper. The shales and soft rock that previously resisted loading by scrapers or ripping with old-type rippers or rooter are now successfully loosened. In one pass the hydraulic unit with three arms spaced at 53 in can loosen a total width of 9 ft to a depth of 12 in.

Ripping procedures vary with the stripping unit. For example, for bulldozing a minimum of passes is made to give the lowest cost. More passes must be made for scraper loading.

In general, rip as deeply as possible. Experimenting with ripping angles and depths is advisable. For scraper loading, rip in the same direction as loading.

Ripping cost compared with blasting cost must be favorable to justify its use. Under typical conditions, a 320-hp tractor with ripper can produce 300 to 600 cu yd per hour.

BULLDOZER STRIPPING—As a result of more speed and power being built into today's bulldozers, they are being used more and more as stripping units. Working in pairs or in conjunction with other equipment, they are effective in moving overburden that normally requires little or no shooting.

Latest models available to the industry include single-engine units powered by engines delivering 230 hp and twin-engined models powered by two 218-hp diesels. Drawbar pull in the range of 60,000 lb or better is a feature of the new high-powered tractors. Modern tractors are available with either torque converters or direct dive.

Where stripping is assigned to bulldozers alone, a minimum of two should work together. For efficient material handling, an average of not more than 35 ft of cover should be moved and the terrain should be gently rolling or hilly to permit easier movement of overburden. Pushing should be 90 deg with the outcrop after the initial cut is made along the outcrop and the bulldozers should work together, one following the other and slightly overlapping the path of the leading unit to pick up side spillage.

After the pit is filled sufficiently, the dozers should start pushing to the main spoil area away from the highwall. As succeeding cuts are made and the highwall gets steeper, it will be necessary for the dozers to rehandle as much as 20% of the material. To establish the highwall, the bulldozers should cut parallel to the outcrop and dig down to the coal. If hard material is met, it should be either drilled and shot or ripped fine enough so that the bulldozers can move it easily.

Bulldozers are teamed with a shovel or dragline to remove overburden in two-seam stripping in hilly terrain in West Virginia (*Coal Age*, April, 1959, p 85).

BOX-CUTTING—Opening a pit by box-cutting involves digging down to the coal and then working straight ahead to the limit of the property. By exercising care in opening a new strip pit along the property line in flat or gently rolling land it is possible to recover practically all of the coal in the tract. In some instances where a shovel or dragline is used to open a new tract along an adjoining property the first-cut spoil is placed on the surface next to the property line. Stripping then advances into the tract and the coal along the property line and under the first-cut spoil is left in place. Some operators do not consider it economically possible to rehandle spoil from the opening box cut and the regular material over the coal. As a result, the strip of coal along the property is never recovered. If a strip of coal 75 ft wide, 4 ft thick and 3,000 ft long is left in place along the property line, the loss will be about 37,000 tons.

AUXILIARY MACHINES—Consider the possibility of using auxiliary earthmoving equipment, such as scrapers and bull-dozers to move the spoil from the opening box cut. It might be possible to start at the property line and cut down 10 to 20 ft of material with scrapers and spread it in a thin layer 4 to 5 ft thick over the surface where it can be easily handled in subsequent cuts. The scrapers could open the area by making a cut 100 to 200 ft wide along the property line. Exact width of cut can be laid out to fit into the overall plan for the regular stripping machine. It may be desirable for the auxiliary machine to cut down an area that is two or more times the width of the cut that will be taken by the shovel or dragline.

If the resulting pile is too high to be moved efficiently by the shovel or dragline when the second cut is made, a bulldozer can be teamed with it to level and spread the material in the spoil area. Or if the material is broken finely enough, it also might be possible to use scrapers effectively in the spoil area. The cost of rehandling the first-cut spoil should be weighed against the value of the coal left in place and the effect on the cost of handling overburden over the life of the mine.

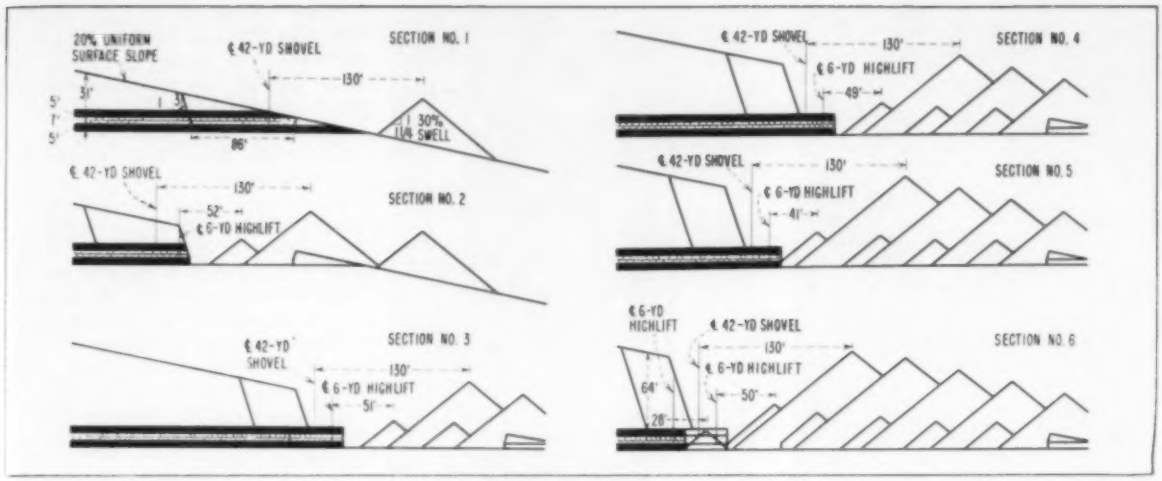
STRIPPING THICK COVER—Where extra thick cover is constantly present, the big dragline is the most popular machine. However, the successful application of the 60- and 70-yd units shows that shovels can not be counted out in the thicker cover. Since going into service in February of 1956, the 60-yd giant's performance has been very satisfactory and the 70-yd machine already is proving its value. Output of the 60-yd machine has been at a rate well over 2,000,000 cu yd per month while working to 80-ft banks.

If only one machine is desired for stripping under consistently thick cover, the dragline usually gets the nod. Improved electrical controls and bigger motors have made it possible for the drags to work to higher banks and move more cover per hour. The result is more material moved at no greater cost than when working to lower banks. Where shovels would be working at extreme range, rehandling materials, or working in two lifts the dragline definitely offers advantages.

TANDEM STRIPPING—Many combinations of machines are removing overburden efficiently. For example, a shovel may be teamed with a dragline in a tandem operation. In this type of set-up, the drag works ahead, taking the upper section of the overburden and leaving the remainder for the shovel. The percentage of material to be handled by each unit depends on the capacity of each and the stripping conditions.

Various other combinations are being used in tandem operations. Where there is a fairly thick layer of soft material at the surface, tractor-scrapers and bulldozers can work on the highwall and cut down a sizable portion of the overburden. Auxiliary equipment also can be used effectively on the spoil pile to permit stripping units to work to higher banks. Where auxiliary units work on the spoil bank, they frequently do a great deal of leveling so that final reclamation or backfilling is not too costly.

MULTIPLE-SEAM STRIPPING—Two or more seams close together frequently can be mined profitably where one alone would not be profitable. The choice of equipment and the mining



TYPICAL CROSS SECTIONS of two-seam stripping show how 42-yd shovel with 130-ft dumping radius takes main portion of overburden on top seam and 6-yd highlift machine skims off the thin layer of rock covering the lower coal.

method depends on the dip and thickness of the coal; the topography of the land; and the type of rock above and between the coal beds.

In anthracite mining, multiple seam stripping usually is on the pitch. Overburden may be moved by any of the standard types of stripping equipment, including draglines, shovels and draglines, or shovels alone. Spoil haulage is common practice.

Where there are flat or nearly flat seams, overburden can be moved by a specially designed shovel (*Coal Age*, August, 1954, p 64); two draglines plus an auxiliary shovel (*Coal Age*, July, 1955, p 56); or a shovel and dragline (*Coal Age*, January, 1953, p 84). The choice of equipment in each case was made to get the best results under the conditions.

The specially designed shovel strips two seams simultaneously from one position in gently rolling country. Both seams are thin and are separated by 16½ ft of rock. Working on the lower seam, the shovel uncovers a 50-ft strip on each level while working to banks up to 60 ft above the upper seam.

The two draglines and auxiliary shovel are used in flexible setup in gently rolling country to mine two seams separated by 3 to 10 ft of limestone. Where banks range between 50 to 70 ft in thickness, the two draglines work in tandem, and where cover is thinner they work separately. The limestone interval between the two seams is drilled with percussion units and the broken material is cast to the spoil area by the coal shovel on the off shift.

The shovel and dragline were teamed to mine two seams separated by about 40 ft of rock in hilly country. Operating procedure is to remove the lower seam back to the outcrop of the top seam, using the shovel to make a working bench for the dragline which completes the cut. Next the shovel removes part of the cover and makes a bench on the upper seam for the dragline, which strips to a 40-ft bank. After this coal is removed, augering is done to complete mining in the upper seam. The next step is to recover the lower seam, leaving a 90-ft highwall. Augering to a depth of 175 ft in the lower seam is the final stage in mining at this property.

One of the newest two-seam stripping operations is the River Queen mine where a 55-yd shovel chews up overburden at the rate of 100,000 cu yd in 24 hr. Designed originally as a 70-yd unit, the shovel was cut to 55 yd so that a longer handle could be used for the two-seam stripping job (*Coal Age*, June, 1957, p 84).

An eight-step system for contour stripping and augering makes it possible for a West Virginia operator to remove 95 ft of overburden while recovering 13 ft of coal from two seams. A vertical overburden drill, 8-yd dragline and two highwall augers are key machines in producing 200,000 tons per year (*Coal Age*, March, 1958, p 90).

Another West Virginia operator recovers four coal beds totaling 16 ft and spaced within a 60-ft vertical interval in a highly flexible operation demanding close supervision. A 5½-cu yd shovel is the major stripping machine (*Coal Age*, August, 1956, p 88).

THE WHEEL EXCAVATOR—The wheel excavator has been developed for use in the United States to cut the cost of moving material in 50- to 85-ft highwalls. The three objectives in using the machine are: (1) to handle overburden up to 85 ft thick, and place the spoil far enough away to avoid slides; (2) to cut the cost per cubic yard below that possible with conventional machines of equal size and capacity; and (3) to leave any overburden not moved by the machine so low in height that capacity of the accompanying shovel or dragline will be increased.

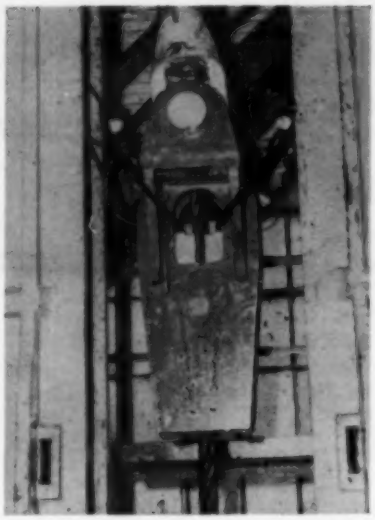
HAULING SPOIL—Whenever possible, thick cover should be removed by casting. However, there are limiting factors, such as, spoil area available and range of the stripping unit. If the coal seam lies flat, is of average thickness and brings only an average sales price, it usually is not profitable to haul spoil. But if the coal is steeply pitching or is extra thick and the sales price is high enough, spoil haulage is feasible as a means of increasing the stripping range. Spoil haulage is most common in the anthracite area and is being carried on to a lesser degree in the bituminous.

Rugged, high-powered, end-dump trucks lead in spoil haulage, with tractor-scrapers and rock wagons moving a respectable portion of the material. In many cases, spoil is hauled to worked out sections of the pit, while in others such as hillside stripping, it is hauled to ravines or below the outcrop. The wheel excavator with its stacker belt also may be classed as a spoil hauler as well as stripper since it carries spoil beyond the limit of the ordinary stripping unit.

PIT CLEANING—Since the goal in stripping is to keep the stripping unit working at full capacity, pit cleanup should be left for auxiliary machines. Rubber- or tractor-mounted bulldozers are widely used for this work, along with the motor grader. The money invested in an auxiliary cleanup machine and its operator is justified by the increase in output of the stripping unit and a corresponding boost in available coal.

Although it pays to have an auxiliary

SAFER, SIMPLER method of supporting the boom on big stripping shovel resulted from engineering studies.



BETTER ROPE CLAMP for 2½-in hoist ropes on 60-yd. shovel eliminated rope slipping or breaking at clamp.

machine clean the top of the coal, the stripping unit should take time to trim loose material on the highwall rather than leave it for the coal-loading shovel. Furthermore, it may be impossible for the coal shovel to reach the loose material and because of the hazard some of the coal will have to be bypassed until the next cut is uncovered. This procedure will result in a ragged pit and possible loss of coal.

WHEEL EXPERIENCE – Operating experience with American wheel excavators show that they can move 1,700 cu yd of overburden per hour and spoil it a maximum distance of 388 ft from the digging point (*Coal Age*, March, 1955, p 58). Power costs per yard are the same as a large shovel and are considerably less than draglines.

A significant saving in drilling and blasting cost is possible with the wheel excavator where it can be used. For example, one Illinois operator was able to shorten blastholes by 30 to 40% while eliminating the problems of hole squeezing and casing through sand. At the same time bit cost was reduced considerably.

At another wheel operation, a wheel strips and spoils 10,000 cu yd per shift, moving 25-30 ft and leaving 30-35 ft for a 33-yd shovel (*Coal Age*, July, 1956, p 60). Cuts taken by both machines are 45 ft wide, but the wheel-excavator cut is offset from 10 to 15 ft from the shovel cut to provide a bench that prevents spillage of the softer top material into the uncovered coal where the shovel would have to re-handle it.

The narrow bench left by the wheel provides another advantage since the shovel can work to a nearly vertical face on the lower bench, instead of having to shape a sloping highwall to prevent sloughing of the softer top material.

Operating Stripping Machines

THE KEY to efficient performance of stripping units is keeping machine productivity as high as possible. The time spent in loading, swinging, dumping and returning for a new load must be kept to a minimum. A fully loaded dipper should be the goal in each cycle. To help analyze machine performance, some companies rely on recorders that indicate work time, angle of swing and the number of swings per shift.

A well-prepared bank makes possible fast loading and the finer the material the faster it can be loaded. But there is an economic limit to the amount of money that can be spent for explosives to break the rock. The type of overburden and the type of stripping unit are important in deciding how much explosive can be used.

IMPROVING DRAG LINE EFFICIENCY–Proper working of the digging face offers the best opportunity for achieving maximum production from a dragline with a minimum of power consumption and wear and tear on the machine. Slicing material off in layers will give more output than working in trenches. However, a "key" or trench cut along the highwall line frequently will ease the rest of the work. The dragline bucket should be loaded as quickly and hoisted as nearly vertically as possible to keep power consumption at a minimum. Poor operation, such as digging on a slope near the machine and lifting the loaded bucket approximately 45 deg with the vertical may consume up to 42% more power.

Quick loading and immediate hoisting will move the most yardage. By keeping the digger area under the boom, dividends will be reaped in greater output. The bucket should be filled while traveling two or three bucket lengths and then hoisted immediately. Every effort should be made to get a full bucket in the short travel but if it is not completely filled, it is best to lift and swing the load. By hoisting the bucket as soon as it is loaded, dirt pileup in front of the machine will be avoided and the danger of drag rope wear will be eliminated.

Sidepulling with the boom over-heats and wears swing clutches, puts unnecessary wear on the flanges of the boom-point sheave and may result in a twisted boom. This should be avoided to keep maintenance down.

ENGINEERING ANALYSIS – Industrial engineering techniques are being applied more and more to help mine management increase operating efficiency. And this practice is becoming more widespread in strip mining. A time study method designed for stripping shovels can be very simple, but the benefits can be large.

To get the most from a shovel time study, conditions under which the unit works must be studied carefully. Shovel performance can be affected directly or indirectly by width of coal pit or strip pit, width of haulage berm, water in the pit, haulage units and depth of overburden.

The type of overburden and how easily it can be dug is especially important. A series of time studies and a careful analysis of the results will show when the most economical point of overburden preparation has been reached.

RECORDER STUDIES–Time studies for shovels can be divided into two types. The simplest is a daily record of how many swings the machine makes and the length, in degrees of arc, of each swing. This information is obtained automatically by mounting a recording device, sometimes called a swing recorder, on the shovel. This device has a spring clock which pulls a roll of graph paper past a moving recording needle. The recording needle is synchronized with the movement of the machine's swing gears and records each swing on the roll of graph paper.

This type of study indicates when no useful work is being done–a straight line appears on the recorder roll. To provide management with information on these delays, shovel operators should be given daily delay forms on which to check off the cause. If these forms are designed properly, all the operator need do is place an X in the proper place to pinpoint the cause of the delay.

From the recorder sheet and the operator's delay sheet, engineers can make a complete report of how much time was spent digging, how much time was lost in delays and the number of swings.

BUCKET MAINTENANCE—Proper handling on the job, coupled with good maintenance procedures, will keep bucket maintenance to a minimum. Among the bad operating practices to avoid are striking the bucket against a solid object to loosen sticking material; dropping the bucket, especially with the teeth down; slapping the bucket against the boom while hoisting; and pulling the drag-bail socket into the fairlead.

Bucket teeth take a beating and must be kept sharp for good digging. Spare sets of teeth should be kept on hand for frequent changing so that worn units can be built up with hard-surfacing materials. Under no conditions should teeth be permitted to become badly worn.

Small cracks develop in the bucket from time to time as a result of accidental abuse. These weak spots should be repaired as quickly as possible to prevent big repair bills later. Many companies find it profitable to buy a minimum of two buckets for each dragline so that bucket maintenance can be done on the regular work shift without reducing dragline output. When repairs are needed the bucket is changed on the off-shift, or with a minimum of delay if the dragline works around the clock. Two buckets kept in good condition and used alternately will last longer than buckets bought one at a time and used continually until worn out.

SHOVEL OPERATION—As with dragline loading, the bank should be removed in slices in shovel work. The thickness of the slice should be such that the dipper will be filled as it reaches the top of the bank. It is usually good practice to dig the top half of a high bank first. This method keeps sloughing into the pit to a minimum and avoids lowering of the dipper to the bottom each cycle. Consequently, cycle time is speeded up and output is increased.

Load indicators also are gaining in favor to show the operator when the dipper is fully loaded and ready to be hoisted (*Coal Age*, October, 1953, p 80). The operator can be trained to hoist and swing as soon as a full load is indicated on a meter in his cab rather than relying on personal judgment. An indirect benefit from load indicators is less overloading and therefore fewer breakdowns.

Short moves should be made to maintain an efficient digging position. Digging beyond the boom point should be kept to a minimum. When working with too much reach, too much time is lost crowding and retracting. Sweeping the dipper back and forth to level off spoil causes side strains and wear on the boom, dipper stick and dipper.

Augering

Since the highwall auger was introduced to the industry, it has grown to the point where it is producing in the neighborhood of 10,000,000 tons a year. When teamed with stripping equipment, such coal-recovery drills have permitted stripping to be done to higher banks. The combined cost of auger coal and strip coal from the higher bank can be made to equal or better the cost when stripping alone is done under thinner cover.

Coal produced by augering usually is dry, clean and has a good proportion of lump sizes. However the proportion of lump usually decreases as the augering depth increases. Where the seam is overlaid by a layer of high-ash coal, selective mining can be practiced and clean coal produced without preparation.

PREPARING FOR AUGERING—If augering is to be done as part of the stripping operation, make preparation as stripping progresses. Care should be taken in blasting so that the highwall will be left in the best possible condition. A highwall slide can endanger the lives of men or result in serious damage to the auger as well as cause a loss in production.

A clean well-drained pit of suitable width for auger operation should be left as stripping progresses. It is much more economical to anticipate the use of the auger and make the necessary preparations as part of stripping than to do it later. It also is desirable to auger as soon as possible after stripping is completed and while the highwall is in the best condition. If there is coal remaining beyond the augering limit, solid blocks of coal should be left to permit access for future deep mining. The size of block to be left depends upon the thickness and type of cover, the thickness and the strength of the coal, and the mining laws.

AUGERING METHODS—Augering usually is done by drilling single holes to the desired depth with a unit that takes nearly the full seam height. However, for seams more than 5½ to 6 ft thick, it is best to use a smaller auger and double drill, preferably overlapping the bottom hole into the top. Staggering top and bottom holes is another method. The depth to which augering is carried out depends to a great extent on the coal thickness, whether the seams roll or are flat, and whether they are strong enough to stand after penetration and not foul the auger. Distance between holes also depends on the strength of the coal and the overlying rock.

Augers are available in diameters ranging from 16 to 52 in, and are capable of producing as much as 800 tons of coal per shift. To increase flexibility in operation, augers are available with conveyors that permit coal to be discharged on either side of the unit.

A three- or four-man crew usually handles all the work involved in the augering and is supplemented by a group of truck drivers.

AUGERING EQUIPMENT—Equipment requirements for augering depend upon the application. For example, if the auger works in conjunction with stripping a bulldozer and trucks will be all that will be needed. Service and maintenance trucks used for the stripping equipment can take care of the auger. If augering is done independently of stripping, either in abandoned strip pits or in areas where no stripping was done, a small shovel and service facilities probably will be needed. The shovel will be needed to provide a working bench along the outcrop or help the bulldozer clean old pits.

AUGERING RESULTS—At one West Virginia operation where a 48-in auger recovers 400 tons per shift, three men perform all the work connected with augering. One man operates a bulldozer to move the auger to new drilling sites and to clean the pit in the augering area. The other two men operate the auger and add or remove auger sections.

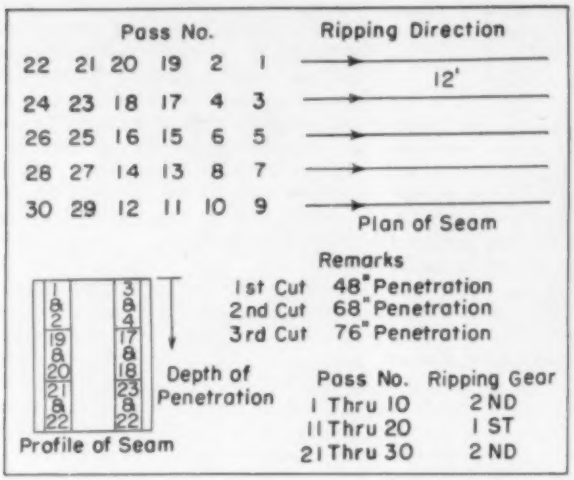
Coal from the auger is discharged onto the ground adjacent to the highwall. When a good size stockpile has been built up, the coal-loading shovel moves in at a convenient time and loads it (*Coal Age*, September, 1956, p 64).

A self-moving 47-in unit works in a mountaintop pit only 26 ft wide. Self positioning with three hydraulic positioning jacks make it possible for the unit to be moved fast and easily to a new hole site.

Three augers, two full time and one spare, are used at this property to recover coal that could not be stripped because of the hazard of spoil rolling or sliding downhill and damaging vital mine installations (*Coal Age*, September, 1956, p 72).

In Ohio, a 30-in self-moving auger produces 400 to 500 tpd in three-shift operation. Working in areas previously deep mined, the unit has produced up to 275 tons in a single shift (*Coal Age*, July, 1957, p 60).

Production of 150 tpd with only six men, including truck drivers, is achieved with a 24-in auger. The company uses trucks for overnight storage to get full-shift operation. Four trucks are used regularly by the two drivers. While they shuttle back and forth between the pit and cleaning plant, the elevator operator


Pass No.
Ripping Direction
22 21 20 19 2 1
12'
24 23 18 17 4 3
26 25 16 15 6 5
28 27 14 13 8 7
30 29 12 11 10 9
Plan of Seam
Remarks
1st Cut 48" Penetration
2nd Cut 68" Penetration
3rd Cut 76" Penetration
Depth of Penetration
Profile of Seam
Pass No. Ripping Gear
1 Thru 10 2 ND
11 Thru 20 1 ST
21 Thru 30 2 ND

BREAKING COAL with tractor-mounted hydraulically controlled ripper is proving an effective aid in keeping production cost to a minimum. Powerful bulldozers make ripping possible in seams up to 6 ft thick.

spots empty trucks. When a truck is filled it is driven from under the elevator and parked headed toward the preparation plant. When a driver returns with an empty truck there is a loaded one waiting for him (*Coal Age*, December, 1956, p 54).

New entries in the auger group are the twin-head and triple-head machines capable of boring two and three holes at the same time. The units break out the small pillar between the holes and thereby increase recovery. Capacity is boosted and as a result, thinner seams that previously could not be mined profitably now may be recovered.

Coal Loading

BREAKING COAL—Where the coal is of average thickness and hardness, explosives used in breaking the overburden usually will loosen the coal sufficiently so it can be loaded easily without being blasted. But sometimes it is too hard to be broken this way or the nature of the overburden may prevent it.

At other operations, it is necessary to drill and shoot the coal in a separate operation. Self-propelled combination machines made up of drills, compressors and brooms are frequently used for this work. Either one or two drill arms are mounted on these units to put down holes in a minimum of time. The power broom is used to sweep the top of the coal before holes are drilled and is disengaged from the power unit during the drilling cycle. Sometimes a handpulled wagon with a gasoline-powered drill is satisfactory.

Another tool for preparing thin seams for loading is the pinning machine. This unit travels over the coal on crawlers, dropping a weighted, pointed steel pin or pins that pierce the coal and fracture it enough to permit easy loading. The advantage of this machine is that the coal can be broken as quickly as it could be drilled, the cost of explosives is eliminated and a minimum of fines is produced.

RIPPING COAL—A new concept in strip mining—breaking coal with a tractor mounted ripper—is proving an effective and economical aid in keeping cost to a minimum. The new technique is made possible by the recent development of large hydraulically controlled rippers mounted on the rear of tractors having engines with more than 300 hp. Unlike former towed rippers which simply trailed the prime mover and exerted no down pressure, the tooth of the mounted ripper concentrates the entire weight of the tractor for maximum penetration.

With tractor weights approaching 70,000 lb, only the tractive effort of the prime mover and the size of the tooth limit the depth of penetration. Ability of the modern tractor to develop up to 54,000 lb of pull at the drawbar makes ripping possible in seams up to 6 ft thick. In an Illinois mine, a tractor-mounted ripper with an 8-ft tooth breaks a 4½-ft seam of coal at a saving of $42,000 per year over conventional methods. (*Coal Age*, February, 1958, p 148).

Ripping a 3- to 6- ft layer of shale on top of the coal and then the coal results in greater coal recovery and a reduction in the quantity of fines and large lumps going to the preparation plant at a western Kentucky operation. Only 45 min is required to rip enough coal for an entire shift of loading. The decrease in fines going to the preparation plant lightens the load on the wet tables and crusher, making it possible for the plant to handle more coal (*Coal Age*, January, 1959, p 82).

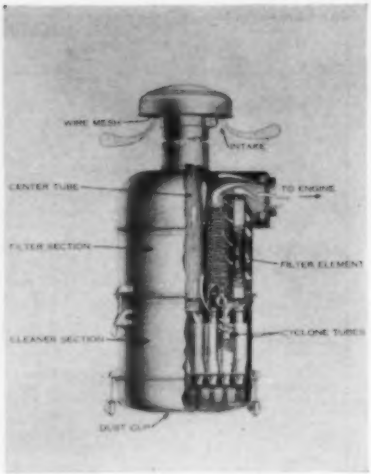
COAL CLEANING – Preliminary cleaning before loading, where desirable, can be done by tractor-scrapers, bulldozers, graders, rubber-mounted scoop loaders or power sweepers. If there are any clay veins in the coal or the top of the coal is very irregular, it may be necessary to remove part of the dirt by hand. Hand cleaning, however, is expensive and should be avoided where possible.

LOADING METHODS – First consideration in choosing a coal-loading machine is to match its capacity to the ability of the stripping unit to uncover coal. Sometimes it is desirable to have excess coal-loading capacity so that any time lost by transportation or tipple delays may be partially regained by faster loading. By loading trucks rapidly with an oversize shovel haulage can be restored to normal in a minimum of time.

SPECIAL SHOVELS – If the coal seam is thin, consider the horizontal-thrust shovel or the skimmer unit, either of which moves the dipper parallel to the bottom while loading. These units have the advantage of scooping up a wide channel of coal without disturbing the bottom. In other instances, a conventional shovel equipped with a specially designed dipper is satisfactory for loading thinner seams of coal.

SPECIAL DIPPERS—If the coal seam is split into two or more parts by several feet of rock, the specially designed dipper on a conventional shovel may work out better. The top layer of coal can be scooped off and then the same shovel can be used to remove the rock covering

CLEAN lubricants, delivered to machines directly from original drums, prolong equipment life. Each drum has its own air-powered grease pump and delivery hose.



DRY-TYPE air cleaner removes greater percentage of dirt from engine intake air.

the lower portion of the seam. If the coal loader cannot be spared for the rock job, the regular stripping unit can be used on the off shift to remove the thin layer of rock.

When the coal is more than 2 or 3 ft thick, but is extremely hard, a divided dipper can be used effectively to limit the size of lump that is delivered to the truck and therefore to the preparation plant.

To minimize spillage when loading the top seam into trucks on the lower seam, a special variable-rake-angled dipper was developed. The dipper is set for the proper rake angle for digging, then when raised for dumping the angle is readjusted through a control in the operator's cab to the proper angle for low dumping. Afterwards the rake angle is reset for digging.

STOCKPILING—Where two-shift operation of the preparation plant is not desirable and the coal is thin, top efficiency from the loading and hauling units can be achieved by heaping the coal to one side of the pit on the off shift so that loading-time will be as low as possible on the regular shift. The loading shovel thus can fill a truck faster and coal will be carried to the tipple faster.

INCREASING COAL RECOVERY—The importance of recovering all the coal that is uncovered cannot be overemphasized, particularly where the seam is thin. If by careless operation of the coal-loading shovel 3 in of coal is left on the botton over an area of one acre, the loss will be about 450 tons. If 10 acres of coal are stripped in a month, the resulting total loss will be 4,500 tons. At a sales price of $4 per ton, this amounts to $18,000 per month.

If working completely to the bottom results in much overshooting or in too much loss of time, and there is considerable coal involved, a bulldozer may be assigned to accompany the loading shovel. It can rip up the bottom coal—with the aid of scarifying arrangements if necessary—and keep it pushed up to the loader with a minimum of digging into the bottom and at a cost still representing a considerable saving over leaving the coal or delaying the loading. If a washing plant with sufficient capacity is available some bottom material can be tolerated with either shovel or bulldozer cleanup. If a washer is not available, more care is required, but it still is possible under many conditions to increase recovery without undue contamination.

Another place where good loading procedure pays off is along the outer edge of the coal where it is in contact with the spoil. If a 6-in strip of coal is left along 1 mi of a seam of coal 60 in thick, the loss will be about 528 tons of coal. At $4 per ton, this will be $2,112. To provide a solid vertical edge and prevent losses such as this, one company developed a marking machine that shears through the coal, marking the loading limit for the shovel and leaving a smooth vertical wall on the bench. Estimated savings were about 200 to 400 tons per acre.

Transportation

SELECTING TRUCKS—Choosing the largest available unit does not always result in a lower haulage cost per ton because final truck selection is based on many factors including production, pit width, types of roads, grades, distances and size of loading shovels. Wherever possible, the size of the haulage unit should be matched to the capacity of the loading shovel. For example, a 5- to 7-yd shovel works well with a 40-ton truck and a 3- to 4-yd shovel teams well with a 25-ton hauler. A good rule of thumb is to use trucks with four to five times the dipper capacity of the shovel.

Overall height of the truck should be such that it makes a good target for for the loading shovel. Length should be minimum and width a maximum so that the shovel loading cycle can be kept to a minimum. Ability of a truck to turn around in cramped quarters in as short a time as possible and get under the shovel without delay should be considered to avoid traffic congestion.

Coal-hauler size runs up to 50 tons in anthracite, and up to 80 tons with tractor-trailer units in bituminous. Power is supplied by engines up to 450 hp. In recent years trailer weight has decreased, and payload and speed have increased by 25 to 30%.

TRUCK DESIGN—New ideas constantly are being introduced in truck design to increase payload or improve performance. For example, tractor-trailers which recently went into service at an Illinois mine feature a tractor that has no front axle. Instead wheels are mounted individually on a spindle which in turn is fastened to a hydraulic shock absorber. The suspension units act as giant kingpins and support the front wheels while making it possible for them to be steered. Two of the units replace the front axle, two are used to spring the drive axle and two support the trailer axle.

With few minor changes, one is also used to connect the trailer to the tractor. One advantage of this type of connec-

HAULAGE TRUCK DELAY REPORT

Date _____

Check No. _____ Driver _____ Truck No. _____

Shift Worked From _____ To _____

From _____ Pit to Cen. Prep. Plant _____ Trips — Speedometer Reading End Shift _____

From _____ Pit to Cen. Prep. Plant _____ Trips — Speedometer Reading Start Shift _____

From _____ Pit _____ Trips — Total Miles Traveled _____

MAINTENANCE DELAYS	MINUTES DELAYED EACH TIME		TOTAL DELAY TIME
TRACTOR UNIT			
Motor		01	
Radiator		02	
Starting Motor		03	
Clutch		04	
Transmission		05	
Front Axle		06	
Brakes		07	
Drive Line		08	
Electrical System		09	
Battery		10	
Tires (front)		11	
Tires (rear)		12	
Springs		13	
Frame–Cab		14	
Hydraulic System		15	
Greasing System		16	
Lubrication		17	
Motor Oil, Filters–Fueling		18	
Cleanup		19	
Rear Axle		20	
Other Maintenance Delays		21	
TOTAL MAINTENANCE	DELAY		
TRAILER UNIT			
Axle		22	
Brakes		23	
Tires		24	
Springs		25	
Frame		26	
Lubrication		27	
Cable		28	
Hopper		29	
Hopper Doors		30	
Air System		31	
Other Maintenance Delays		32	
TOTAL MAINTENANCE	DELAY		
NON-MAINTENANCE DELAYS			
Loader Broke Down		33	
Waiting for Truck Ahead to be Loaded		34	
Delay at Tipple		35	
Other Non-Maintenance Delays		36	
TOTAL NON-MAINTENANCE	DELAY		

Truck No. _____ **LIST REPAIRS NEEDED**

Driver _____

Special forms are useful in keeping close control over truck maintenance costs.

HANNA COAL COMPANY

PAGE 1

Division of Pittsburgh Consolidation Coal Company

TRACTOR AND TRAILER UNITS _____ Mine _____, 195__ & Year to Date

	MAINTENANCE COST			YEAR-TO-DATE MAINT. COST		
TRACTORS:	Labor	Supplies	Delays	Labor	Supplies	Delays
Motor						
Radiator						
Starting Motor						
Clutch						
Transmission						
Front Axel						
Brakes						
Drive Line						
Electrical System						
Battery						
Tires (Front)						
Tires (Rear)						
Springs						
Frame–Cab						
Hydraulic System						
Steering System						
Greasing System						
Auxiliary Equipment						
Painting						
Lubrication						
Antifreeze						
Motor Oil						
Cleanup						
Rear Axle						
Check & Fuel Trucks						
Filters						
Other						
TOTAL						
TRAILERS:						
Axle						
Brakes						
Tires						
Springs						
Frame						
Lubrication						
Cable						
Hopper						
Hopper Doors						
Air System						
Other						
TOTAL						
NON-MAINTENANCE:						
Loader Broke Down						
Waiting for Truck Ahead to be loaded						
Delay at Tipple						
Other						
TOTAL						
Maintenance Labor						
Maintenance Supplies						
Operating Labor						
Operating Supplies						
Depreciation						
Supervision						
Vacation Pay						
Labor Burden						
TOTAL						

PAGE 2

TRACTOR AND TRAILER UNITS _____ Mine _____, 195__ & Year to Date

Total Tons Hauled:	Month	Year to Date
Raw Coal From _____ Pit to _____		
Raw Coal From _____ Pit to _____		
NUMBER OF TRIPS:		
_____ Pit to _____		
_____ Pit to _____		
NUMBER OF MILES		
_____ Pit to _____		
_____ Pit to _____		
Miles/Trip		
Tons/Trip		
Ton Miles		
Cost/Ton		
Cost/Mile		
Cost/Ton/Mile		
Hours Delayed		
Hours Operated		
Hours Scheduled		
Percentage of Scheduled Hours Delayed		
Percentage of Scheduled Hours Operated		

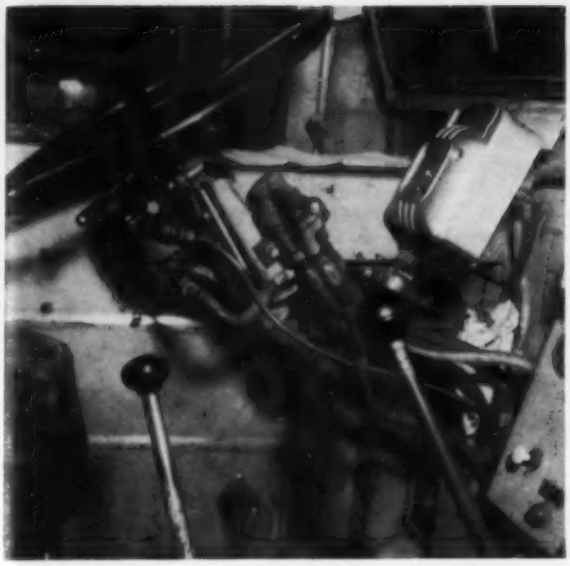
* Summary of Overspeeds on Georgetown No. 12 Mine

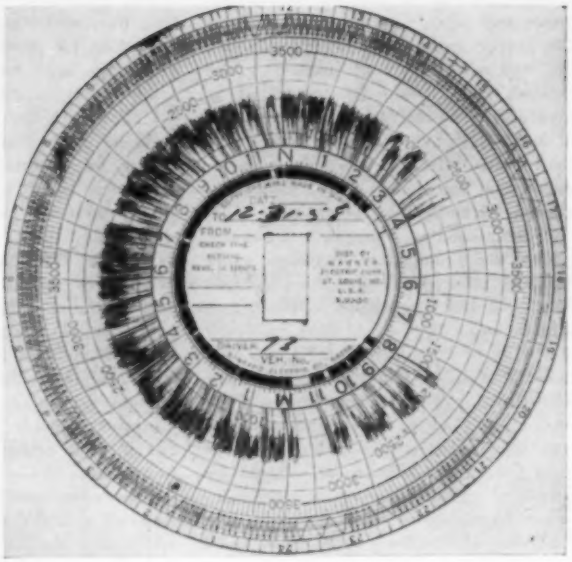
HAULAGE TRUCKS

Truck No.	1st Shift	2nd Shift	3rd Shift	Total
65	–	–	–	–
66	–	–	–	–
67	–	–	–	–
68	0	1	0	1
69	0	6	11	17✓
70	0	0	0	0
71	–	–	–	–
72	0	0	0	0
73	1	0	0	1
74	–	–	–	–
75	0	0	0	0
76	7	6	6	19✓
77	39	28	32	91✓
78	0	0	0	0
79	–	–	–	–
TOTAL	47	33	49	129

* From an analysis of tachometer charts.
Date: January 5th, 1959
1-6-9: ac

DAILY REPORTS on maintenance and non-maintenance delays, details of maintenance costs, work done by trucks and truck overspeeding provide management with valuable information on equipment performance.





RECORDING tachometer in truck cab provides a daily chart of engine speed, helps keep overspeeding to a minimum. A typical 24-hr chart is shown at right. Charts should be sent to office for checking.

tion is that the loaded trailer is carried on a cushion of air; hence, shocks are absorbed by the connecting member rather than transmitted directly to the tractor. Another advantage is that the connection is located 30 in ahead of the centerline of drive axle and thus gives capacity loading of the front axle.

A special airplane-type propeller cooling fan is used on the engine, saving 66⅔% in the power required for cooling. Controlled thermostatically, the fan runs only when engine temperature is above 190F.

The use of alloy steel for fabricating trailers capable of carrying 80 tons of coal results in more payload per trip. Other improvements in design make it possible for the unit to carry 4.4 cu yd per foot of trailer compared to 2¾ cu yd in a conventional trailer.

TORQUE CONVERTERS—Torque converters make for smooth truck operation, less lugging and lower maintenance. They also have made it possible for loaded trucks to climb steep grades, thus shortening haulage routes. In some cases, a 48-ton truck with torque converter can haul coal at up to 30% less per ton-mile than a 37 ton truck with a standard transmission on the same route.

AIR STARTERS—Air starters have been used effectively on large coal haulers to eliminate all batteries except the 6-V units for headlights. Starters are operated by compressed air supplied at 100 psi from a storage tank on the tractor. Trucks can stand idle for 4 or 5 days and there still is enough air in the tanks to start them.

HYDRAULIC RETARDERS – Hydraulic retarders are now available for controlling the speed of trucks on long steep downgrades. The unit also acts as a governor. Mounted on the drive shaft of the truck, the device is designed so that when the shaft speed increases, the retarder resistance automatically increases at a much faster rate. Therefore any tendency of the truck to run away is curbed by the retarder which piles up resistance very rapidly when the truck's speed tends to increase. A control valve near the driver regulates the degree of braking available by controlling the oil passing into the retarding device. Aside from slowing the truck, the device is said to save tires, fuel, time and brake lining.

ENGINE HEATERS—Cold-weather starting of truck engines is simplified at an Ohio mine by electric engine heaters. Each engine has its own electric heater which has an aluminum jacket enclosing a 2,500-W heating element. It is permanently installed in the engine's cooling system.

At the end of the shift each driver parks his 51-ton coal hauler beside the shop and connects the heater to one of the all-weather outlets mounted on the outside of the shop wall. The heater keeps the engine water temperature at about 120 deg. As a result, little or no difficulty is experienced in starting the engines in sub-zero weather.

TRUCK-RAIL HAULING – Where the haul is over 3 or 4 mi, the topography is favorable and sufficient coal reserves are available, the use of a field station and rail haulage to the preparation plant is worthy of consideration, particularly since the advent of the small diesel locomotive. With this type of setup one man can load a trip of cars, haul it to the preparation plant, dump it and return to the field station in a minimum of time. A minimum of trucks are needed to shuttle back and forth between the pit and the field station. Consequently, truck maintenance costs also are lower and fewer men are needed for operating and servicing trucks. A further advantage is that road maintenance will be lower.

OVERLAND BELT—An added starter in the transportation field is the overland belt system that carries coal from portable bins near the pit to the cleaning plant (*Coal Age*, August, 1954, p 64). Where the land is gently rolling and stripping can be carried out in a wide area, the overland belt offers the following advantages:

1. Eliminates the cost of building and maintaining long, high-speed haulage roads.
2. Permits movement of larger tonnages with fewer and/or smaller trucks.
3. Permits recovery of belt after the property is worked out. Roads cannot be recovered.
4. Reduces the manpower required for maintenance of trucks.
5. Requires a smaller supply inventory and less garage space.

Road Building

Main roads should be built with wide beds and have good alignment to permit trucks to run at top speed. All curves beyond the gentlest should be superelevated.

Roads should be planned well in advance and when fills are needed to get the proper grade, they should be built up well ahead of the time they are needed. Fills should be compacted as they are made and topped off with one or more feet of rock that will serve as a road base. After this material is compacted, a top layer of crushed rock should be added and compacted. This top layer usually is applied in several layers and compacted between each. Material used for the top layer includes Nos. 3, 4 and 6 crushed limestone, 2-in slag or red dog.

SURFACE MAINTENANCE—One or more road graders, depending on the length of road to be maintained, are used at most operations to keep the running surface smooth. Roads should be sprinkled regularly during the dry, dusty season not only to maintain good visibility but also to keep dust out of truck engines and moving parts, thus helping to reduce maintenance needs.

EFFECT OF GRADES—Grades should be avoided as much as possible to keep power requirements down. For example, it takes twice as much force to move a 20-ton load up a 5% grade as on the level. Where grades must be negotiated, stepped-type roads can be used to advantage. This type of road involves alternate stretches of level road and short comparatively steep rises. Therefore less clutching is required in trucks equipped with standard transmissions and there is less lugging on the up grade and over-speeding on the down grade. Constant shifting and lugging results in reduced life for engine, transmission and clutch.

Entrances to the pit should be one way if possible. Turning and backing large haulage units takes time and thus reduces haulage efficiency. Proper design of turn-ins can eliminate this problem.

SNOW REMOVAL—In winter, roads should be cleared of snow before trucks start to operate. This will prevent formation of slippery conditions caused by compacted snow. A motor grader, started several hours before trucks begin to travel, should be able to clear an average snowfall. If there is a severe storm, bulldozers should be added to help move the snow off the haulage roads.

Power

IN LAYING OUT a distribution system, three primary factors are involved. First, the system must be able to supply the equipment without objectionable voltage regulation from an operating standpoint and at the same time stay within reasonable economic limits. Second, the system must provide adequate protection for personnel and equipment. Third, the units in the system must be adaptable to relocation to keep up with the change in the load requirements.

Public utility companies supplying the energy for operating strip mine equipment are faced with the problem of greatly increased demands on their systems. Many times they have been able to handle this increased capacity by switching to higher voltage transmission lines. Mining companies using large quantities of energy can get a more favorable contract if they receive power at the higher voltage. To do this the customer must purchase a transformer substation capable of reducing the voltage to that required for the portable equipment.

Energy is now often received and metered at 33,000 or 66,000 V. Thus the user builds the higher voltage transmission lines from the metering stations to the portable substation units located near the area to be stripped.

TRANSFORMATION — Voltage may be reduced in either a one- or two-step transformation. With one-step transformation, primary mine distribution usually is 2,300 or 4,160, with 6,600 and 7,300 V coming into the picture as a result of heavier demands imposed not only by the increase in machine use but by higher horsepower per machine. In two-step transformation, the "super-primary" voltage usually is 13,000. Permanent transformer stations may employ either single- or three-phase transformers, with a trend toward the latter. A number of strip operations also employ semi-portable stations completely or to supplement permanent stations. Commonly called unit substations, they are based on three-phase transformers. Typical ratings are 1,500, 2,000 and 2,500 kva, with the top usually 5,000. Normally these stations include lightning arresters, circuit breakers, ground-protective equipment and other central and protective facilities.

PRIMARY DISTRIBUTION—Primary distribution systems generally fall into three general classes:

1. Pole-mounted high lines.
2. Cable systems.
3. A combination of pole lines or lines and cable line or lines.

Pole-line practice is largely standardized, with a main line a maximum of 1 mi in advance of the pit and parallel to it. From this main line, pole-line laterals at intervals of 1,200 to 1,500 ft are run to the pit, terminating in switchhouses which supply auxiliary transformers for low-voltage equipment, and also supply the cables on the larger high-voltage equipment. As the pit moves across country, the laterals are shortened at intervals until the pit approaches the main line, which then is moved to restart the cycle. Cables on the equipment usually are 1,000 ft long. Thus, with a lateral spacing of 1,200 to 1,500 ft, equipment can operate freely between laterals with enough cable to spare to permit terminating laterals some distance back when shortening is necessary.

SUBSTATIONS IN PARALLEL—The latest development in strip mine power systems is operation of substations in parallel (*Coal Age*, October, 1956, p 60). At the present time two skid-mounted 1,500/1,725-kva substations are in operation with plans for adding a third unit. The pit power distribution system is entirely by portable cables and multi-conductor plugs and sockets.

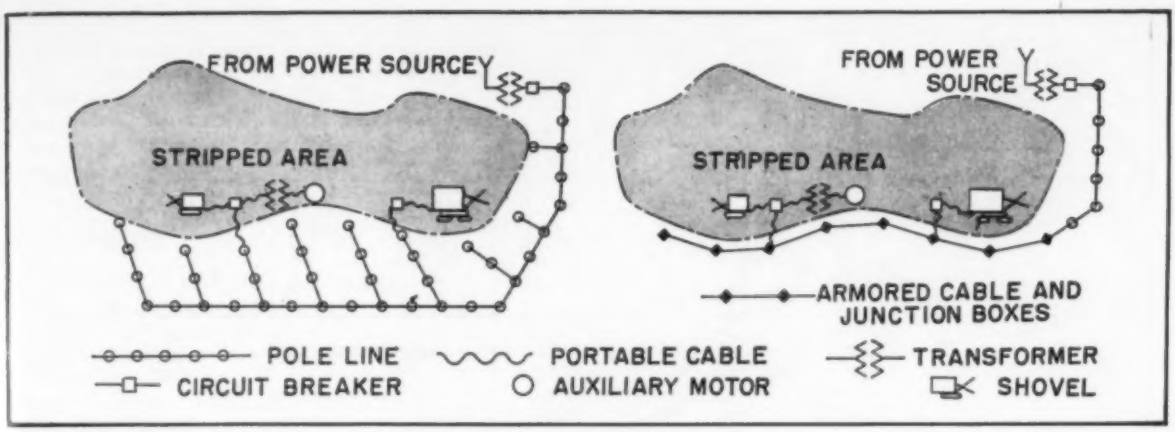
Special mine power cables are used between breaker skids. The cable is similar to the Type SHD portable shovel cable in that it has a copper basket weave over individual conductors. It differs in that it has smaller ground conductors and a thinner outer jacket. This type of cable was bought at a saving of approximately 40%. It is used exclusively on the highwall and seldom, if ever, will it be necessary to move it while it is energized.

The theoretical ideal conditions for paralleling three-phase transformers are:

1. Same phase rotation
2. Same phase-angle shift
3. Same polarity
4. Identical turn ratios and voltage ratings
5. Equal per cent impedances
6. Equal ratios of resistance to reactance.

Since the substation units at this mine are identical, the last five items above are automatically taken care of. To parallel two or more substations phase rotation must be the same. Phase rotation refers to the order in which the terminal voltages reach their maximum values. In paralleling, those terminals whose voltage maximum occur simultaneously are in phase and are connected together by the circuit breaker. Each substation unit is equipped with necessary equipment that will not permit the breaker to be closed, paralleling two substations unless the voltages on both sides of the breaker are the same phase. Added safety features are incorporated within the substation design to indicate to the operator of the substation the unit voltage level and load at all times on both sides of the breaker.

GROUND-CABLE SYSTEMS—A fair number of strip mines use the "ground-cable" system instead of pole lines, or a combination of ground cables and pole lines. Otherwise, the basic plan is the same. A complete system consists of the



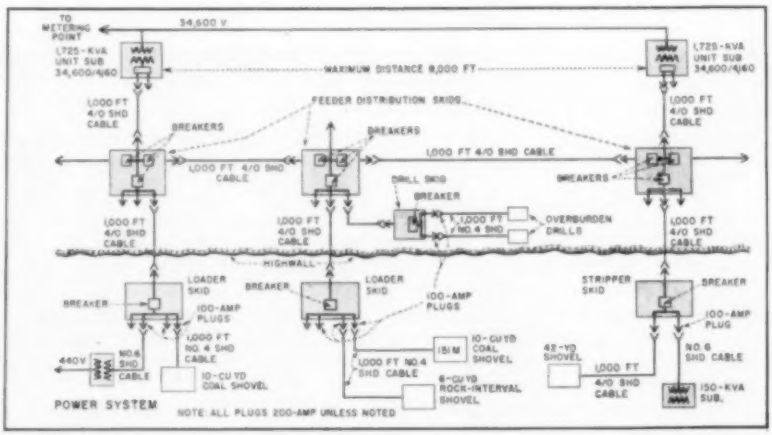
POWER distribution systems at today's strip mines include both lateral pole lines and armored cables.

main cable and the laterals, the cable being fabricated in sections of 1,000 to 1,500 ft as a rule with connectors for termination in switch-houses or for joining the main-cable lengths by junction boxes. Several types of cable may be employed but the most common is Type SHD. Construction includes copper shielding braid over each insulated conductor to equalize surface stresses and eliminate static discharge—the cause of corona cutting. The shielding must be at ground potential at all times, and therefore must be properly grounded, which also eliminates the hazard of shock in handling the cable. Grounding conductors are placed in interstices. It is the safest and most widely used for high-voltage (up to 15,000) portable power applications.

Within limits, distance of transmission of 4,160 volts becomes critical, as a rule, only with the heavy loads encountered in the use of large shovels and draglines rated from 20 to 25 cu yd and up where connected horsepower per unit runs from approximately 2,000 to 5,000. Under such circumstances, the transmission distance for 4,160 volts normally should not exceed 5,000 to 6,000 ft. Above that, at high-voltage—33,000 for example—a pole line is cheaper to construct and also improves regulation and reduces power loss.

With the success of the 60-yd unit and advent of the 70-cu yd shovels, operating voltage moved up to a new high of 7,200 volts. Power is fed directly to the shovel cables from 5,000-kva transformers after passing through automatic circuit breakers.

The 6,900-V cable to the 60-yd shovel has one of the three gound wires insulated and a 110-V potential is maintained between the uninsulated ground wire and the insulated wires. On the shovel there is an annunciator circuit connecting the insulated wire and the equipment frame. Thus any broken



HOW power is distributed in loop system that has two easily moved skid-mounted substations plus portable auxiliary units.

frame to ground connection will warn the operator of the fault.

CHOOSING PROTECTION—Primary items involved in the selection of a protective grounding system include:

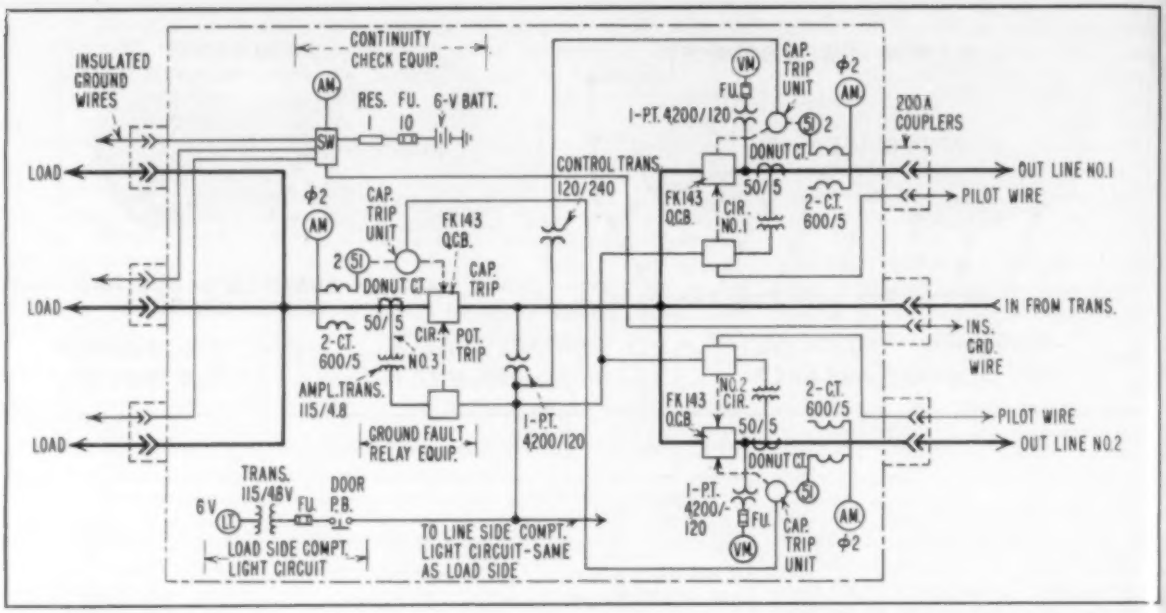
1. The maximum value of machine frame to ground voltage during a ground fault.
2. The magnitude of fault impedance that can be relayed.
3. Provisions for checking continuity of the ground-wire circuit.
4. Establishing a protective ground separate from the substation ground.
5. Proper choice and rating of components to maintain low frame-ground voltage in event of failure to trip on a ground fault.
6. Immediate isolation of a faulted feeder from the remainder of the system.

FRAME GROUNDING—The frame-to-ground voltage that is developed under fault conditions is approximately the ground current times the impedance of the ground wire. This is the potential to which a man standing on the ground and touching the machine would be subject to when a ground fault occurs.

In a system having a resistor limiting ground fault current of 25 amp where the ground-wire impedance in the cable is 2 ohms, the machine frame-to-ground voltage would be 50. In a system having a 50-amp ground current limit and a 2-ohm impedance in the ground wire, the voltage will be 100.

If more than one substation is used and each has its own ground-current limiting resistor to keep each ground current at 25 amp paralleling them will permit a total of 50 amp to flow in the ground wire in event of a ground fault. The potential drop in the ground wire then would be 100 V. If more than two similar substations, each with its own ground-current limiting resistor are used the total ground current that would flow in the cable ground would be the sum of all substations.

The grounding resistor will establish the maximum ground current that can flow under solid fault conditions. The tripping current that would isolate a faulted feeder should be considerably less. The ratio of limit value to ground relay pick-up value determines the fault



ONE-LINE DIAGRAM of triple-breaker skid shows how ground-fault and continuity-check circuits are built in.

resistance that can exist and still obtain tripping. The higher this ratio the greater the fault resistance can be for relay pickup. It is improbable that a high-resistance will clear, therefore its immediate isolation is advantageous. The ability to relay a high-resistance fault is important in safety grounding systems.

For example, one recommended plan uses a 25-amp ground-current limiting resistor and a ground-detecting transformer and relay combination set to trip at 5 amp ground fault. On a 4,160-V system this resistor value from ground to each phase would be 96 ohms. In a 4,160-V system the line to neutral voltage is 2,400. Thus a total resistance—grounding resistor plus ground wire plus 2,400 divided by 5, or 48 ohms can still obtain 5 amp in the ground circuit. Subtracting the 96 ohms of the resistor from the 480 ohms would permit 384 ohms in the fault. Thus fault resistance between 380 ohms and 0 ohms could be relayed.

Successful functioning of the safety grounding circuit depends on the ground conductors from the machine frame back to the substation being intact. If the ground is broken or an open terminal connection develops, the protection is impaired.

CONTINUITY CHECKS—There are various ways of checking ground-wire continuity. Sometimes a check is made at the start of the shift by imposing an artificial ground fault on the unit and noting tripping of the feeder breaker. The latest method is to provide continuous monitoring of the ground-wire circuit. Sometimes an alarm sounds in the equipment and warns the operator that the ground circuit is not intact. Other methods actually trip the supply breaker. In each of the continuous systems either a pilot wire is required in the cable or one of the grounding wires must be insulated from the other ground wires.

SUBSTATION GROUNDING—To minimize the rise in potential of the protective ground and the frames of mobile machines to which it is connected during the lightning arrestor discharge, or in case of flashover of any of the substation equipment, the substation protective ground resistor should be connected to a separate ground. This ground should have as low a resistance as possible—under 5 ohms—and should be located some distance from the main substation ground.

BREAKER SETTINGS—Since one of the main purposes of the grounding system is to isolate a faulty feeder as quickly as possible, ground fault tripping on the breaker unit nearest the load should be made instantaneous. If there are other breaker units between the load and the substation, these should be set for the same ground current as the unit nearest the load but provide selective tripping on a time basis.

POWER FACTOR—To prevent power penalties resulting from power factor below that specified in the power contract, synchronous motors, 0.8 leading, are installed on the m-g sets on large excavating units. Without correction, power factor would usually average between 68 to 85%, but with the proper correction will be up to 90 to 95%, which will be above the penalty area.

CABLE TESTING AND FAULT-FINDING—Insulation failures and shorts in high-voltage distribution or service cables in strip pit can cause major delays unless special facilities are provided for locating them. Without such special equipment, about the only method is to apply high voltage and current and blow the cable up at the point of fault.

Equipment for testing and fault location may be made or purchased. A testing outfit that may be made up from purchased components employs, among other items, a half-wave rectifier tube and filament and plate transformers to produce DC at up to 30,000 V and 40 milliamp, or sufficient to test up to 7,500 V. In operation (*Coal Age*, May, 1953, p 108) voltage is applied slowly to one conductor, with other conductors, shield or shields and ground wire or wires grounded. When the cable is fully charged, the current flow is the true leakage current, registered on a milliammeter. The voltage is held for a period and leakage current is determined at intervals to develop a polarization curve. The shape of the curve indicates the electrical condition of the cable and exposes potential insulation weaknesses.

For locating faults, the test equipment is modified by the addition of a spark gap and condenser. Location is achieved by picking up the discharges sent forth by the condenser and spark gap, which are audible at the trouble spot if there is water soaking or there is not a dead short. Where this is the situation, the observer has only to walk

the cable. If the fault resistance is very low, dead ground or under water, a pickup coil and earphones are employed and the fault point is marked by a change in the signal. Commercially developed units may be purchased to achieve the same results.

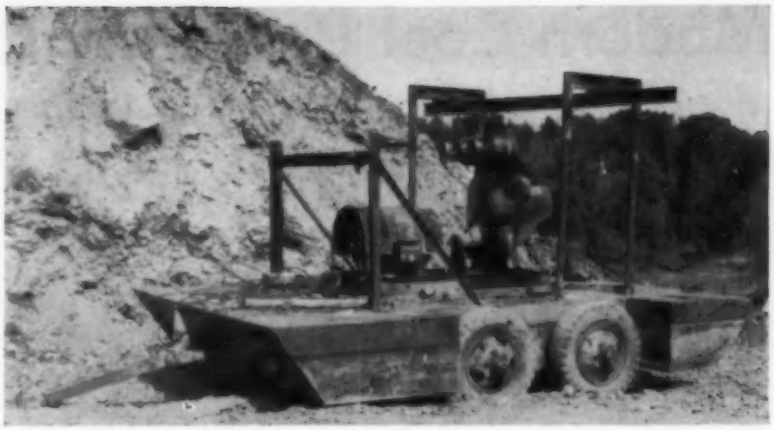
Drainage

PREVENTING INFLOW—To keep drainage costs to a minimum, water should be kept from entering the pit and off the haulage roads. Several ways of doing this include: (1) diverting streams to new channels to prevent seepage into the work area; (2) ditching above the highwall to divert surface runoff away from the pit; and (3) building flumes to span the pit.

GRAVITY DRAINAGE—When water does enter the pit, as a result of rainfall or seepage, gravity should be used as much as possible to remove it. By exercising care in spoiling, leaving windows in the spoil areas or putting in crib culverts or drain pipes at intervals, water can be handled economically. If grades favor it, one end of the pit may be kept open to release all the water. In some cases it will pay to blast a ditch in the pit floor so water can flow by gravity to a drainway through the spoil area.

PUMPING—Portable pumps, either mounted on skids or wheels, are the leaders where pumping is required. These are used in a variety of sizes and capacities, depending on the job to be done and are powered either by electric or diesel motors. Many of the units are controlled by float switches that stop or start them automatically, thereby cutting labor costs.

The hose is popular for temporary water lines but is frequently supplemented by a variety of new materials, including flexible plastic, special rubber and aluminum pipe. Resistance to corrosion, rot and abrasion have made plastic pipe more popular, while ease of handling makes aluminum desirable. Threadless couplings, in addition to the advantage of fast joining and installation of pipelines, also permit individual joints of pipe to be rotated 180 deg if a small leak occurs in the bottom as a result of abrasion. Thus pipe life can be greatly increased. Check valves should be included in all suction lines to eliminate the need for priming pumps. However, this may not be desirable in cold weather when there is danger of the lines freezing. If corrosion and abrasion are problems, impellers and pump interiors can be coated with rubber-base material to increase their life.



AMPHIBIOUS pump carrier, at home on land or water, requires a minimum of attention. Unit carries large 10-in pump.

SELF-PROPELLED pump is one way of solving the problem of removing water from isolated areas. Unit can cut own road.

NEUTRALIZING WATER—To prevent acid water from entering the water sheds of surrounding streams, one company developed an automatic device that provides low-cost water neutralizing (*Coal Age*, February, 1957, p 101). Six sumps, each with its own pump, are strategically located on the property. Each pump has a separate automatic treating tank. Water is treated automatically with lime solution and delivered to settling areas before it is permitted to enter the water basins.

A steel mixing tank at each pump is partially filled with water and 400 lb of hydrated lime is added. As the lime enters the tank it is thoroughly mixed with the water by a power-driven agitator.

Lifting cups attached to one end of the agitator pick up the solution at one end of the tank and discharge it into an adjustable trough at the top of the tank. The trough leads to a 2-in hose that carries the lime solution to a point adjacent to the pump suction line. As the solution flows into the acid water it is pulled into the suction line of the pump. In the short journey to the pump and in the pump itself the solution is mixed thoroughly with the acid water.

A tank of solution lasts each pump for 2½ to 4 hr, depending on the acidity of the water. The quantity of solution delivered to the sump is controlled by moving the adjustable trough.

An automatic lime-feeding device requiring no power other than the water itself provides low-cost water treatment in isolated areas at a Pennsylvania strip mine (*Coal Age*, March, 1958, p 148). Features of the unit include operation by as little as a 1½-ft fall of the water being treated; functioning on 5 gph or less; light enough to be carried to the site if necessary; automatic proportioning of lime according to volume of water being treated; adjustable lime feed to meet varying acidity; and 2 to 8 hr of operation without refilling.

Modern Coal Preparation

Objectives

Proper size for the particular consumer application.

Maximum Btu content per dollar spent by the customer through elimination of impurities and moisture.

A high degree of uniformity in all characteristics—size, heat content, ash and so on. Uniformity can be even more important than, for example, the last word in ash removal.

Maximum convenience in use by such means as dustproofing, oil or chemical treatment to facilitate unloading and handling in cold weather, and so on.

Conduct of the preparation operation to attain maximum recovery of coal values at lowest possible cost.

Basic Approaches

Determine to the maximum degree possible what the reachable markets require in size of product; ash, sulphur, heat and moisture content; and dustproofing, freezeproofing and other convenience factors.

Study the coal to see how it fits market requirements and how it can be processed—at reasonable cost—to enhance its value to the consumer and thus its market position.

Design plant or additions to reduce operating labor by automatic equipment and controls, and to reduce maintenance by use of modern long-lived materials.

Operate plant to recover the maximum in coal values, including installation of auxiliary recovery units when economically feasible, and to insure that performance standards and market requirements are invariably met.

Raw-Coal Storage

MINIMUM CAPACITY where storage is designed to provide a reserve against production interruptions, rather than merely as a convenience in dumping and transferring coal, normally is at least ½ hr of rated plant capacity. Anything less is not likely to be of benefit in reducing or eliminating the consequences of irregular plant feed or mine or plant breakdown.

Much-larger storage is an increasing trend, using either single bins, multiple bins or ground facilities. Bin capacities of up to 2,500 tons single and more in multiple are fairly common, as also are ground-storage installations up to 10,000 tons or more.

Underground Storage

Capacity of one hopper feeding a slope belt at a plant rated at 500 tph is 260 tons. The hopper is 16 ft wide and 66 ft long. Maximum depths is 18½ ft. Designed to receive coal from a belt system this hopper is fitted with a shuttle-type distributing conveyor with hinged boom end. The boom section permits laying coal into the hopper with minimum degradation. The shuttle principle also makes possible maximum use of bin capacity.

The dumping characteristics of dropbottom cars also permit maximum use of bin capacity and thus can cut down size and depth; for example 96.7 tons in a bin 40x12 ft by 10 ft deep.

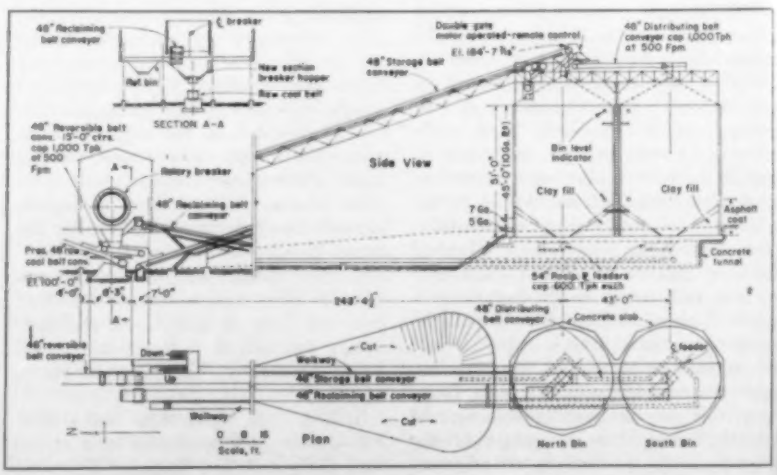
Size of underground hoppers occasionally reaches as much as 2,000 tons. Usually hoppers of this size are employed where there are two seams close enough together so that the hopper can be excavated in the interval to receive coal from dropbottom cars.

Surface Storage

Although some form of bin or hopper still is the most popular form of surface storage of raw coal there is as previously noted a trend toward open or ground storage.

Two examples of surface storage designed to permit return of the coal via the main slope belt are shown in the accompanying illustrations. In one, capacity is 200 tons in the form of a glory hole. However, if the discharge end of the recirculation belt was elevated and a bulldozer or dragline was added, as in certain other installations, capacity could be raised to 10,000 tons or more. In the second design, additional capacity is attained by using a hinged stacker belt. Here, too, capacity may be increased by lengthening the stacker belt and adding a bulldozer, dragline or other reclaiming unit.

Even where slopes are not involved the trend today with large storage setups is to use belts for both stacking and reclaiming. A single pile may be laid down in the form of a cone by discharge from a stacker belt with a fixed end. Or the



STORAGE IN DUAL BINS provides for blending in addition to a capacity of 3,000 tons of raw coal. The bins are preceded by a rotary breaker and supplement a dump bin with a capacity of 1,000 tons.

STORAGE WITH FIXED-DISCHARGE STACKER providing a capacity 5,000 tons.

STORAGE WITH REVERSIBLE STACKER BELT results in two conical piles, one for each seam.

stacker belt may be arranged with one end on a truck running on a curved track so that an arc-shaped pile can be formed. Or a strung-out pile of any desired length can be formed by using a stacker belt equipped with a traveling tripper. Straight or conical piles lend themselves better to reclamation by subway conveyor, now the usual practice.

DOUBLE PILING—Double conical piles may be formed by feeding to a reversible belt. By the proper arrangement of feeders and short reclaiming belts, coal may feed out of either or both piles for preparation alone or as a blend. Another method of forming double conical piles is by the use of boom conveyors preceded by a flygate as shown in the accompanying plan. In this instance, the bottoms of the cones are in pits formed by excavating to make it possible to feed the coal out completely without supplementary equipment.

The plan illustrated also exemplifies a common practice in storing raw coal, i.e. preliminary reduction in size and rough cleaning in a rotary breaker. The flygate in this particular installation is remotely controlled, electrodes are installed on the ends of the boom conveyors to raise them automatically when the coal level reaches them. One of the funnel-shaped storage pits has a capacity of 3,000 tons; the other 1,500 tons. Feeders under the pits put the coal on the reclaiming conveyor. A more uniform raw feed to the plant, with better final quality, is one of the advantages.

If the piles are placed flat on the surface of the ground it usually is necessary to employ a bulldozer, scraper or other unit to move the coal to the feeder after the natural center draw is completed. Boom-type stacking conveyors also provide one answer to the problem of reducing degradation in piling. With fixed-discharge conveyors,

BIN OR SILO STORAGE on the surface includes this 2,400-ton silo unit preceded, in accordance with growing practice, by preliminary breaking and feeding facilities.

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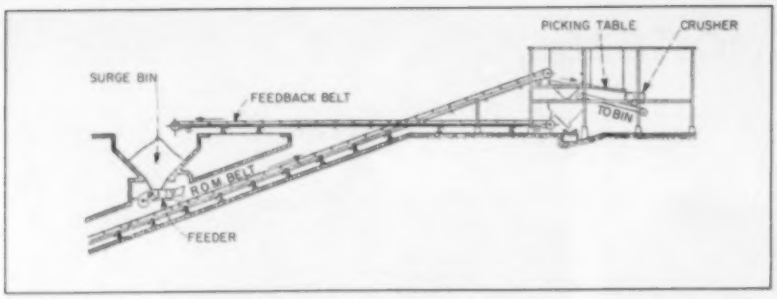
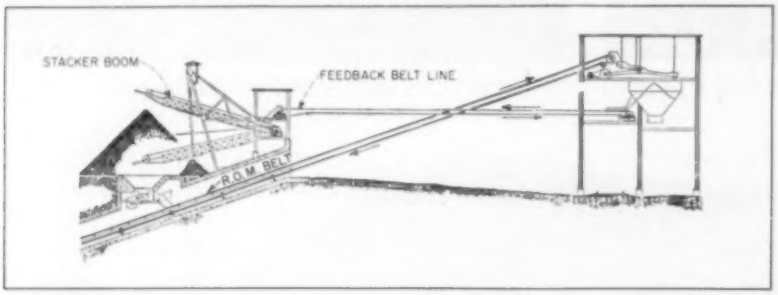
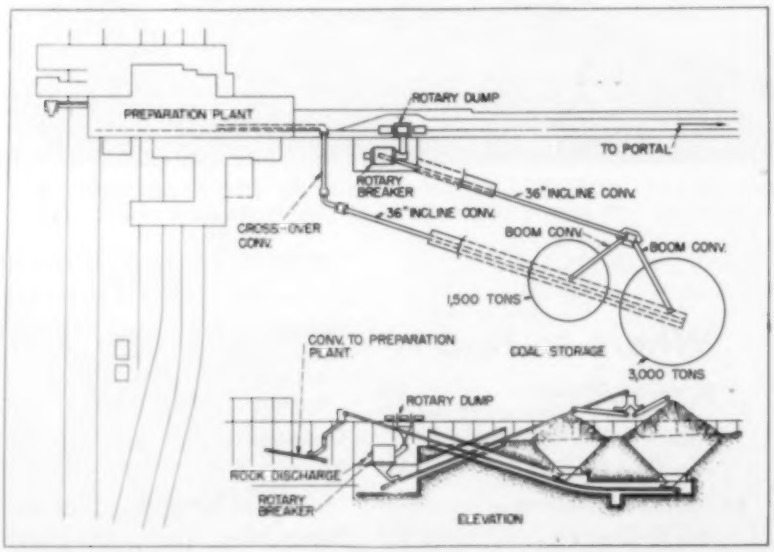


RETURN VIA SLOPE BELT is a feature of this ground-storage plan using a feedback conveyor to place the coal in a hopper. Storage with this system is limited by the size of the hopper or surge bin.



INCREASED CAPACITY in ground storage over slope belt is provided by stacker boom. Raising end of feedback belt and using a bulldozer or dragline for reclaiming is another method of increasing capacity.



GROUND STORAGE here involves rough cleaning, distribution to two funnel-shaped pits by boom conveyor, and reclamation by feeders to subway conveyor.

lowering spirals or ladders normally are required.

Ground storage may be accomplished by dumping from trucks in a flat pile with bulldozer spreading. Reclamation may be by standard shovel and trucks or by tractor-mounted shovels.

BIN STORAGE—The conventional square or rectangular bin—steel, concrete or timber—still is the most-used method of providing raw-coal storage where open or ground storage is not employed. Two old hopper cars, one on top of the other, have been used in some instances. However, the round, or silo-type, unit is being increasingly installed. The silo may be built by conventional concrete-pouring methods or may be constructed of regular plate or prefabricated steel sections, or of precast concrete staves bound with steel hoops. A silo 24 ft in diameter and 55 ft high will hold up to around 600 tons.

Compartmented or multisilo bins are employed at a number of mines for greater flexibility in storage and also to provide some degree of blending of the raw product. Distribution to a side-by-side or four-cornered multiple unit may be by chutes and flygates. Indicators and remote controls permit operation of gates and proper distribution without having a man at the bin.

Distribution to long multicompartment bins may be handled by a belt with tripper. Other methods include a wheel-mounted shuttle belt similar to that employed in loading railroad cars which is moved back and forth to place the coal in the proper compartments. Or a scraper conveyor with fixed openings or movable gates may be used.

In deep bins, degradation may be reduced by installing spiral or ladder-type lowering units.

Raw Coal Blending

BIN FACILITIES—Since the usual goal in blending raw coal is splitting it up into small increments and then recombining it, also in small increments, the normal blending plant consists of a multicompartment bin with a relatively large capacity—usually 1,000 to 2,000 tons or more. The more the compartments within reasonable limits, the more the opportunity for splitting and recombining. Also, to facilitate putting small portions of coal into each compartment the usual practice is to employ a belt with a traveling tripper, though other methods of distributing the coal may be employed. To complete the recombining—and blending—coal normally is withdrawn from all compartments at the same time. Variable-speed feeders are common for this purpose.

Normally, the coal is placed in the blending plant after preliminary cleaning and crushing.

A less-common type of blending is getting the desired mixture of coal from, say, two different seams. This requires a bin or set of bins for each, which may be filled in any of the usual ways, including dumping directly from mine cars or from railroad cars at a central or "milling-in-transit" plant. Blending of two coals also may be accomplished by feeding as desired from side-by-side ground-storage piles to a plant feed conveyor.

PROPORTIONING—Where two or more coals may come via belts from different mines, belt speeds may be controlled automatically to insure that the desired blend is constantly maintained. Weighing devices on each belt transmit signals to motor controls and these in turn adjust the speed of the satellite belt or belts while the final belt receiv-

ing coal from the others runs at a fixed rate (*Coal Age*, August, 1958, p 108). Other types of feeders may be similarly equipped if desired.

Primary Breaking

PRELIMINARY BREAKING and certain rough cleaning usually go hand in hand, although, for example, if coal is being transferred from a hopper to a crusher preceding a slope belt underground, no attempt is made as a rule to remove rock or impurities before the breaking process. On the surface, however, it is generally accepted that where substantial quantities of rock are encountered it is best to remove at least part of it before sending the product to the crusher. Consequently, particularly where all the coal is to be washed, it is common practice to employ a picking table or—as is increasingly the case — scalping screen and picking table ahead of the crusher.

Preliminary breaking is almost entirely the province of the roll-type machine although some pick breakers are employed to get closer to the desired objective of reduction with a minimum production of fine sizes. An alternate also providing rough cleaning is the rotary screen-type breaker.

Roll diameter, tooth design, tooth positioning and speed are major factors in holding down fines, along with keeping teeth in good condition at all times. Double-roll crushers are considered to give a higher proportion of coarse material because abrasion against the plate is eliminated. Feeding practice also influences results in this direction. Consequently, usual practice is to scalp out fines and send only large material to the crusher.

STAGE CRUSHING — In anthractite, particularly, stage crushing has been the practice for many years because of the nature of the raw product and also the size list produced.

To avoid a multiplicity of units, crushers are offered with a second stage of reduction built into them.

Crushers normally are built to handle iron, particularly if it is not too large. However, the better practice is to keep it out not only of crushers but of the entire plant circuit. If possible, therefore, magnetic removal equipment should be installed in the circuit ahead of raw-coal crushers.

Rough Cleaning

THE MAJOR rough-cleaning methods are as follows:

1. **Picking table** receiving all the mine-run product.

2. **Scalping screen** followed by a picking table. This is a preferred system, since it removes the fines and thus facilitates picking, which may be either rough with the idea that final impurity removal will take place in mechanical cleaners, or may be final where the coarse coal is to be loaded without any further treatment.

3. **Rotary screen-type breaker**, which accomplishes both a reduction to a certain top size, depending upon the size

Field Reports

Low-Cost Heavy-Media Cleaning—New unit provides middlings product and requires only one pump in medium circuit. Low initial and operating costs cited for installation operating on anthracite egg and smaller. *Coal Age*, July, 1958, p 80.

Electronic Coal Proportioning—Automatic system controls conveyors to achieve exact blend of coals from two mines prior to cleaning for making quality coking coal. *Coal Age*, August, 1958, p 106.

Fine-Coal Recovery From Silt Ponds—Cleaning and conditioning include laundering, tabling, classification, froth flotation and cyclone thickening. *Coal Age*, October, 1958, p 116.

Cyclone Washers for Fine Coal—How Europe employs cyclones with magnetite medium to produce a primary or primary and secondary products. Feed ranges from ½ in down to 48 mesh. Separation is sharp, recovery is good and final ash is low. *Coal Age*, December, 1958, p 118.

Improving Coking-Coal Quality—Electronic weighing and proportioning feature 600-tph plant for metallurgical coal. Sand-cone and table equipment clean coarse and fine sizes. Cone circuit provides for continuous desilting, and bowl-type desiltors precede tables. *Coal Age*, February, 1959, p 112.

Pushbutton Loading—Controlled by loading-chute operator electronic-pneumatic car retarders permit automatic loading and weighing at 720 tph. *Coal Age*, February, 1959, p 118.

Dry Cleaning and Washing Fines—New facilities cut ash 3 percentage points. Capacity is 150 tph. Included are air tables, 2-cell fine-coal washer for cleaning secondary air-cleaner refuse, cyclone thickeners and dust collectors. *Coal Age*, March, 1959, p 88.

Desliming and Heat Drying—Advantages of removing minus 100- to 200-mesh material prior to washing. Among other things heat-drying is simplified. At this property a fluid-bed-type unit was installed to remove 25 tph of water from 230 tph of ⅝x0 feed, cutting moisture from 14½ to 4-4½%. *Coal Age*, March, 1959, p 104.

Fine-Coal Installation—New addition for 200 tph of ¼x0 solidifies metallurgical position. Installation includes tabling, thickening, filtering, and mechanical and thermal drying. *Coal Age*, April, 1959, p 102.

Designing for Low-Cost Preparation—Goal in supplying power market is lowest possible fuel cost. Design trends include precise quality control, minimum raw-coal handling to reduce cost of fine-coal facilities, and automation to reduce labor costs. *Coal Age*, April, 1959, p 126.

Coarse- and Fine-Coal Cleaning—Dense-media bath handles 4x¼ and feldspar jig cleans ¼x0. Auxiliary equipment includes centrifugal dryer, and cyclone and filters for fine refuse. *Coal Age*, May, 1959, p 74.

Thermal Drying in 1957—Tonnage handled by types of dryers by states. USBM study shows that 10½% of coal cleaned in 1957 was thermally dried. *Coal Age*, June, 1959, p 114.

Super Preparation Plant—Incorporating four independent coarse- and fine-coal circuits with a total capacity of 1,500 tpd, new super plant features one-man control of 90% of operations. Facilities include tank-type heavy-media vessels and twin-deck tables, plus centrifugal and heat drying, thickeners, vacuum filters, flotation cells and dust collectors. *Coal Age*, July, 1959, p 80.

of perforation, and rejects the hard rock —or at least that portion of it larger than the perforations. Normally, where rotary breakers are employed final cleaning is done in mechanical equipment.

4. Conventional screen to accomplish the same result as that attained with the rotary screen-type breaker. In one instance, a vibrating screen first removes the fines, after which the lower section functions to remove rock which rides over while the softer coal drops through

5. Roughing cleaners to throw out the major part of the heavy material and prepare the feed for the final units. Fines may be bypassed around the roughing unit, while large lump usually is processed by hand picking. Preliminary breaking may also precede roughing with a mechanical cleaner. A further refinement is hand picking to remove coarse, heavy material, followed by breaking and roughing.

Rough cleaning by hand frequently precedes breaking, as noted in the previous section, and has the advantage, among others, of reducing the load on the breaking unit and reducing the output of fine sizes in the breaking operation by getting the hard, heavy rock out of the way.

Separate headhouses or roughing plants are being increasingly employed for preliminary breaking, rough cleaning, mine-rock disposal and raw-coal screening.

Raw-Coal Sizing

THE SHAKER SCREEN, inclined at approximately 15 deg and with a crank or eccentric drive providing a stroke of around 6 in and a speed of 100 to 120 strokes per minute, is the common type of raw-coal sizing device. It is receiving increased competition, however, from vibrating screens, usually of the mechanical type.

A major difference between the two types of screens lies in the fact that the shaking unit also can be employed to convey and distribute the products, including provision for hand picking, as in plants preparing by hand picking and screening.

A second difference between the two types of screens is the fact that the vibrating type, though it cannot do conveying, provides higher capacity in a given space in many instances. Degradation with either depends upon type of coal, type of screen and method of operation.

FLEXIBLE SUSPENSION — The flexible-arm or Parrish-type screen, usually operating at 150 to 185 rpm, 5- or 6-in stroke, 2- to 5-deg slope, is another form of shaker. However, its major use is more for final sizing and dewatering, especially in the anthracite field, where it is widely used for this purpose. Laminated-plastic hangers are now used on such screens instead of boards (*Coal Age*, September, 1955, p 67). Advantages include longer life, no change in length and better screen action.

Carrying the flexible-suspension idea still further, a new shaker employs ¾-in wire ropes instead of hanger boards or rods. Consequently a minimum of stress is transmitted to the structure. This is made possible with a new-type drive that employs the principle of rotating counterweights and retains the stresses within the drive unit itself while imparting shaking action. The screening units may be single or double. In the latter the opposed units discharge to a common chute at the center.

Screening Factors

In addition to inclination, speed and length of stroke (or amplitude with vibrators), some of the factors affecting screening results are:

1. Depth of bed. Since screening can be accomplished only when the smaller sizes work their way down to the plate, depth of bed, in conjunction with size of opening and square footage of screening surface, is a major factor. With large openings, depth of bed may be greater. With smaller openings, bed depth must be reduced or the area of screen surface must be increased. Time on the screen also is a factor, though the opportunities for increasing it are somewhat limited. Where it is increased degradation and breakage tend to increase with it.

2. Degradation. As previously noted, time is a factor in degradation. Narrow shakers also tend to increase degradation, and there is a major increase when more screen surface is provided than is necessary to accomplish the desired separation.

3. Wear. Heavy loads, coarse material and the possible presence of considerable rock are factors in wear on raw-coal screens. Among the answers for vibrating equipment is heavy alloy wire or alloy plate. On shakers, types of plate used to reduce wear include cast manganese.

Hand Picking

FROM THE STANDPOINT of impurity removal, hand picking normally is effective only on coal 3 in or larger in size. Hand picking may also be employed to improve appearance by removing off-standard material.

Where bony by itself or in combination with good coal is fairly high in percentage, some operators use picking as a means of removing this material, which then is crushed and sold as a power-plant fuel.

Under reasonably good conditions, where the impurity content is high, one picker can remove as high as 6 tph. Under average or poor conditions with a lower impurity content, production may drop to 1 to 2 tph.

Picking Equipment

Picking facilities include belt and apron conveyors, shaking tables and, occasionally, chain conveyors, the latter normally being employed only under special conditions and where the impurity problem is a minor one. All conveyor-type units lend themselves to combining the table with the loading boom.

The flat-topped apron conveyor and the shaking table best meet the major goal of removal of impurities without lifting or other handling beyond sliding the material removed to the discharge point. Other types of conveyors normally require skirtboards over the rollers or along the edges and thus necessitate lifting each piece to remove it.

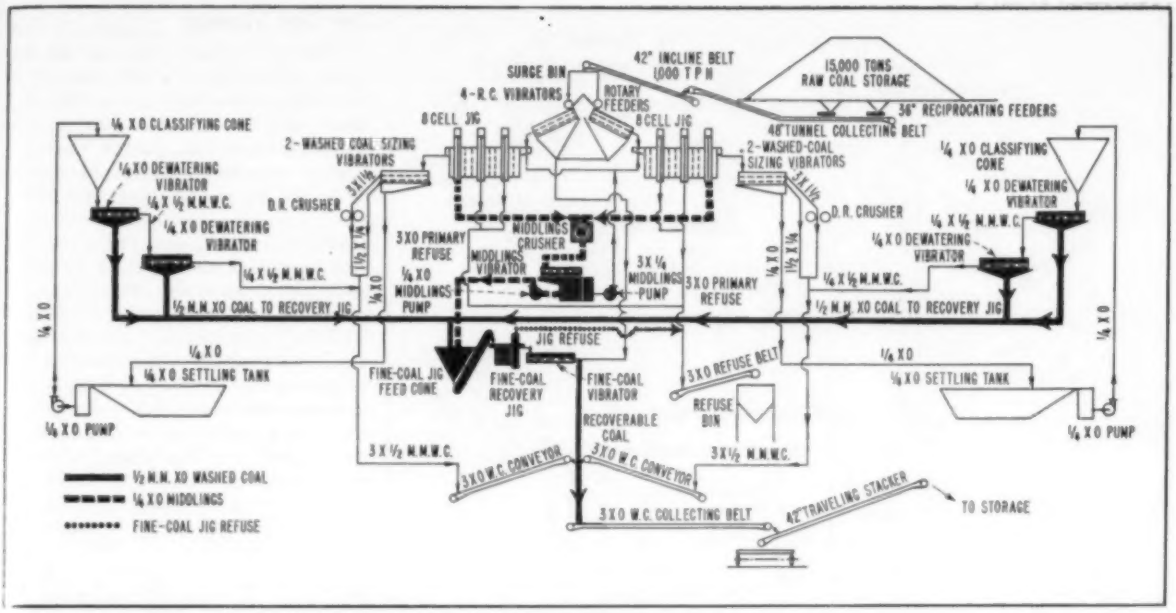
The flat table may be a part of the shaking screen or may be separate. When separate, the table normally is sloped at about 5 deg and is operated at 150 to 160 rpm, 4- to 5-in stroke, crank or eccentric drive. Platform tables used in anthracite have a pitch of ½ to ¾ in in 12, with a 2-in stroke, 370 to 400 strokes per minute. The shaking table also lends itself readily to degradation removal by the installation of a screen section at the discharge end.

Some shaking tables have been equipped with partitions or deflection plates to further ease the load on the pickers by making it possible for them to do no more than push impurities out of the main stream to the center or pull them to the side. Refuse chutes should be equipped with bars to prevent passage of pieces large enough to block the refuse conveyor.

Washing

WHAT ACTUALLY HAPPENS in the separation of coal and impurities is a complex and to some extent unknown physical process. Particle size and shape are involved, as well as the resistance of the medium used to movement of particles through it, and the fact that coal is cleaned as a mass of particles, with consequent interference between free movement of particles within the cleaning medium.

Since the ideal condition for separation of coal and heavier refuse is a still bath of the proper gravity, and since the true or artificial solutions come closer to this condition, the sharpness of separation is increased. This has led to growing use of heavy mediums and solutions — sand and water, magnetite



FINE-COAL FLOW to new jig includes ½mmx0 from dewatering screens plus ¼x0 middlings. Sizes are blended in feed cone before passing to jig. Two jigs process 25 tph each of coal containing 25% ash.

and water, calcium chloride and others.

Other factors which may favor the use of a heavy medium include more-than-normal irregularity in quality and quantity of feed; a need for changing gravity from time to time; and operation at less than 1.45, where baths without upward currents theoretically offer the best conditions for a sharp separation, though capacity per square foot of area may be reduced.

GAGING SEPARATION DIFFICULTY—A good indication of the difficulty of separation is the amount of material in the raw feed that lies close to the gravity of separation. In other words, the greater the percentage of near-gravity material, the more difficult, as a rule, the separation. A good indication of the efficiency of a cleaning operation is the quantity of misplaced material—coal in the reject and reject in the coal. To apply this measure, however, the inherent ability of the cleaner itself to separate coal and refuse must be known, since cleaners vary in their ability to achieve a given separation. Evaluation of this ability is a somewhat complex process, but methods of achieving it include those in "Evaluating Preparation Results," *Coal Age*, April 1950, p 80.

In the main, however, if the washer is properly selected, is kept in adjustment, and is properly operated (see suggestions later in this section) it will provide the requisite separating efficiency. Basic in selection is detailed knowledge of the characteristics of the constituents of the feed.

Where it is evident that the problem may be difficult and the maximum in efficiency is desired, it may pay to wash sizeable tonnages in pilot equipment or actual going plants to check test results. The results of washing a new coal may also be predicted by mathematical or statistical methods, such as that described in "How to Predict Results of Washing a New Coal," *Coal Age*, June; 1952, p 98.

Factors in the application and operation of washing equipment include the following:

Washing Practice

SIZE SPREAD IN FEED—Certain types of washers require a rather small range in the size of the feed. Examples include the mechanical jig, classifier-type units, and certain washers using heavy media. The emphasis in design in recent years, however, has been toward equipment that will handle a rather large range of sizes—for example, the air-pulsated jig and the usual heavy-media equipment. The latter, incidentally, is now offered for handling a top size of feed ranging to 12 to 14 in.

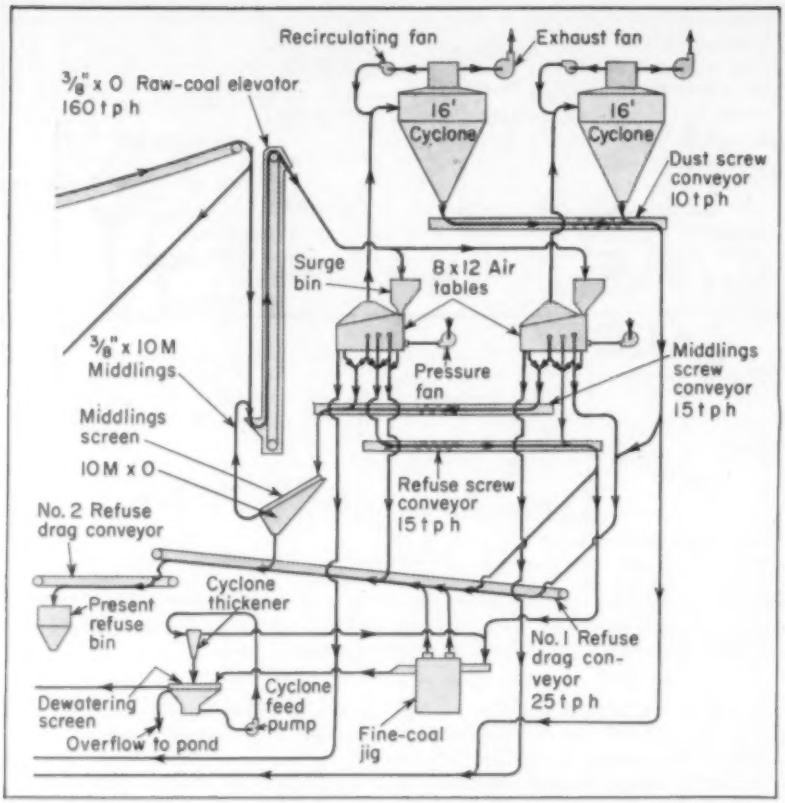
Even where the washer is designed to take, say, all coal from 6 in down to zero, and can frequently do a good job on all the fractions in such a feed, some compromise must be made. Consequently, if tonnage is fairly high and a sharper separation is desired throughout, the practice is to install separate units for the coarse and fine fractions—for example, one for 6x1 or 4x1, and a second for 1x0. Where the equipment requires a closely sized feed, the only out is to install separate units for each fraction it is desired to clean.

BY-PASSING FINES—Fine coal, say ¼ in or less, may be by-passed around washing equipment (1) to keep it out of water and thus avoid the ensuing drying and handling complications, (2) to permit more efficient operation of washing equipment installed to handle a rather wide size range, and (3) because of the problems involved in mixing of fines with medium, such as, sand and magnetite. The fines may be subjected to further treatment in other equipment or, if both their quantity and ash content are not too great, may be mixed back into the washed coal.

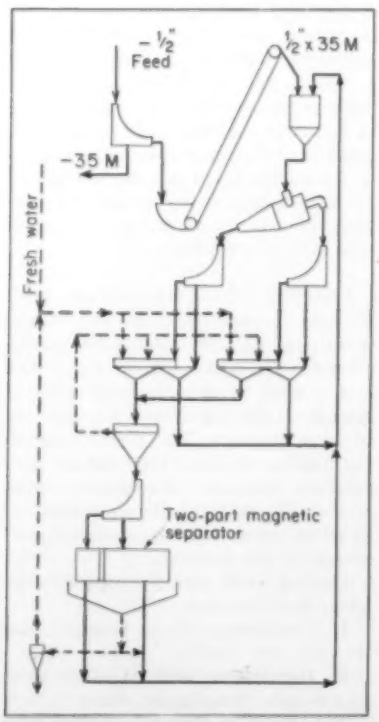
UNIFORM FEED—A uniform feed, both in quantity per hour and in impurity content, adds measurably to the efficiency a washing unit can reach. The best method of attaining uniformity in quantity is the installation of some form of surge hopper or bin, plus a mechanical feeder, ahead of the washing unit. Attaining uniformity of impurity content is normally achieved by some form of blending equipment, as discussed previously in this section.

Feeding faults with jigs especially include the following:

1. **Overloading**—More tonnage than the unit can handle.
2. **Unbalanced feed**—More material to one side than to the other.
3. **Segregation**—One side or the other receives the bulk of the fines.
4. **Bad transverse distribution.**
5. **Interruptions**—Stopping and restart-



RETREATMENT OF MIDDLINGS from air cleaners is the function of the fine-coal jig in this flowsheet for ⅜x0.



CYCLONE WASHING CIRCUIT for ½x0 features bent-sieve screens for desliming and simplification of magnetite reclamation.

ing a jig or other washer usually affects results materially.

6. **Fluctuations**—These, plus interruptions, are held by some authorities to warrant very substantial expenditures in raw- and clean-coal storage.

7. **Screen-plate troubles**—Loose plates or screens with holes can break up stratification and result in complete plugging of the cell with coal.

FEED CONDITIONING – Prewetting either in the feed chute or on special prewetting screens facilitates separation when the material reaches the washer, and consequently is finding increased use.

DESILTING—Another form of conditioning is removing coal fines from the sand used in sand-flotation cones. The goal is continuous desilting, which is accomplished in one new installation by flowing the sand and water to a German-developed radial screen. The material is fed onto the sloping screens by four revolving arms, and as it flows across the screens is washed with fresh spray water. The oversize, or silt, flows by gravity to the silt sump, while the undersize, or sand and water mixture, is pumped back to the sand circuit for reuse.

Fine Coal Washing

With the increase in the use of machines, including the continuous type, the output of the finer sizes under, say, ¼ in, and the ultrafines under, say, 28M, is increasing. As a result, there has been a corresponding rise in special equipment for cleaning fines and ultrafines.

Installation of fine-coal cleaning equipment does not, of course, automatically provide a profit. For example, if 2% of the output was minus 28M but could be beneficated to make it acceptable, the cleaning would be feasible but the coal would wind up in 5 to 7 tons of water, which would have to be removed at a cost of up to $3 per ton of water. Under such conditions, it manifestly would be cheaper to spend the money to mine fresh coal.

As a modification, if the output of, say, minus ⅛-in was 5 to 6% it might work out that the 1 to 2% of, say, minus 48M, could be discarded because of the extra cost of drying, making possible the recovery and cleaning and drying of the remainder at a profit.

FINE-COAL UNITS – Equipment now used for coal from, say ¼ in down to around 28M or 48M includes the following:

1. **Continuous upward-current** washers.

2. **Washing tables,** including new double-deck units that double capacity in the same floor space. The importance of proper feeding is reflected in the number served by feed distributors.

3. **Fine-coal launders.**

4. **Fine-coal jigs.** Such jigs have found rapidly increasing use for both virgin coal and middlings from other types of cleaners. Feldspar is used as the bed in the most-recent of the fine-coal types. Two accompanying flowsheets show the use of fine-coal types in cleaning middlings, both from jigs (after crushing) and air tables.

5. **The heavy-medium cyclone,** which also can handle coarser sizes—up to approximately 1¼ in. The lower limit, in the light of European experience, is about 10 mm. A European cyclone flowsheet is shown in an accompanying illustration. The cyclones are laid almost flat and the pressure is low—in this particular instance, 15 ft of head. Bent-sieve screens are used for desliming and for unloading water and medium, thus material reducing requirements for rinse-and-drain screens and magnetic separators.

Advantages cited for the cyclone include much less plant space, easy arrangement in multiple units separating at different gravities, no effect on sharpness of separation as a result of variations in load and raw-coal composition,

low degradation, and ability to predetermine the separating gravity.

For coal under approximately ⅛ in, or more usually under 28M, and containing material smaller than, say, 48M, the available equipment includes:

1. Flotation units, discussed in more detail later in this section.

2. The bulk-oil process, using 5 to 10% of oil by weight and because of these large oil requirements considered more a possibility for metallurgical coal where part of the oil can be recovered in the coke-oven by-product fraction.

Classifiers and centrifuges might also be considered fine-coal cleaners on occasion. This results from rejection of the extreme-fine fraction which might carry the bulk of the ash.

Media Handling

SELF-GENERATION—Though usual practice in the U. S. is to purchase sand or magnetite, medium can be generated in the plant itself. At a British colliery, for example, the medium is a carefully controlled size fraction of the tailings from a froth-flotation plant. These are extracted from minus-60M feed by cyclones, which reject a substantial proportion of the minus-250M material. The facilities supply sufficient medium for six coarse-coal separators with a total capacity of 850 tph.

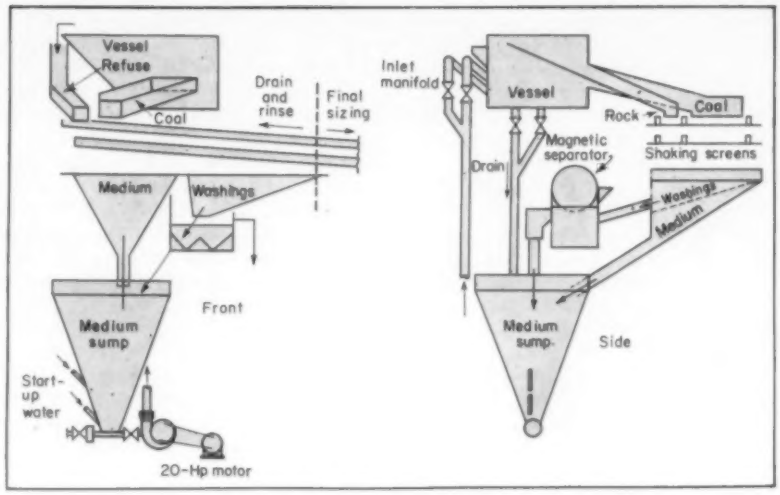
This plant also cleans medium by flotation to prevent coal buildup. Two cells operate on the dilute medium from the rinse-and-drain screens to preserve specific gravity and viscosity of the feed to the separators.

MEDIA CONDITIONING – Reclamation and treatment of the media used in heavy-media systems is necessary for at least two reasons: recovery of an expensive material that otherwise would be lost, and preservation of the proper gravity of the bath in the cleaning unit.

With magnetite, the simplest system consists of a magnetic separator to reclaim the material, previously magnetized to permit this to be done, from the water from the rinse and drain screens. This recovered material then is demagnetized and sent on to a thickener or densifier, from which it is returned to the separator bath.

Variations include use of thickener with overflow back to the rinse and drain screens for part of the water, and underflow to a magnetic separator discharging reclaimed medium to a densifier. Tailings go to a second magnetic separator, also receiving part of the rinse and drain water, with reclaimed magnetite to the densifier and tailings to waste.

Each of several heavy-medium separators in another plant is provided with two magnetic separators which return a concentrate of 2.2 sp gr and about 95% magnetic content directly to the medium circuit without further treatment. Tailings from all separators flow to a desliming sump. The underflow from the sump goes to two 12-in cyclones. Cyclone overflow is used as rinse water, while the underflow is reprocessed.

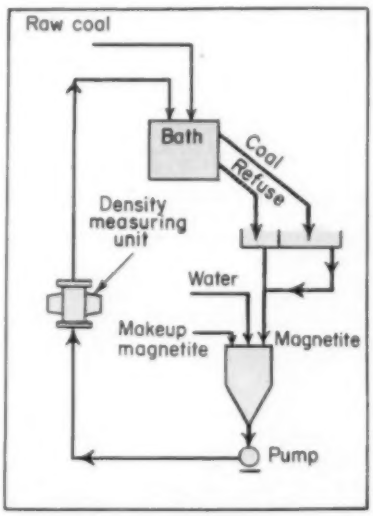


SIMPLIFICATION OF THE MAGNETITE CIRCUIT is attained in this design by combining rinse-and-drain with final screening.

DENSITY CONTROL – Automatic control of bath density is provided for in equipment employed with certain new heavy-media cleaning units. At one installation (*Coal Age,* October, 1955, p 63), rinsing is done only on the lower sections of the drain and rinse screens, thus yielding heavy and dilute medium solutions, the former going to the recirculating sump and the latter to a magnetic separator delivering reclaimed medium to the same sump. Adjustment of the density of the medium is performed by automatically adding water as required to the medium returned to the recirculating sump.

At another plant employing the diptube principle (*Coal Age,* May, 1956, p 69) the reclamation circuit involves magnetic separator, cyclones and a thickener immediately above the coal-cleaning equipment. Automatic valves release medium from the thickener as necessary to keep gravity of the bath at the desired figure.

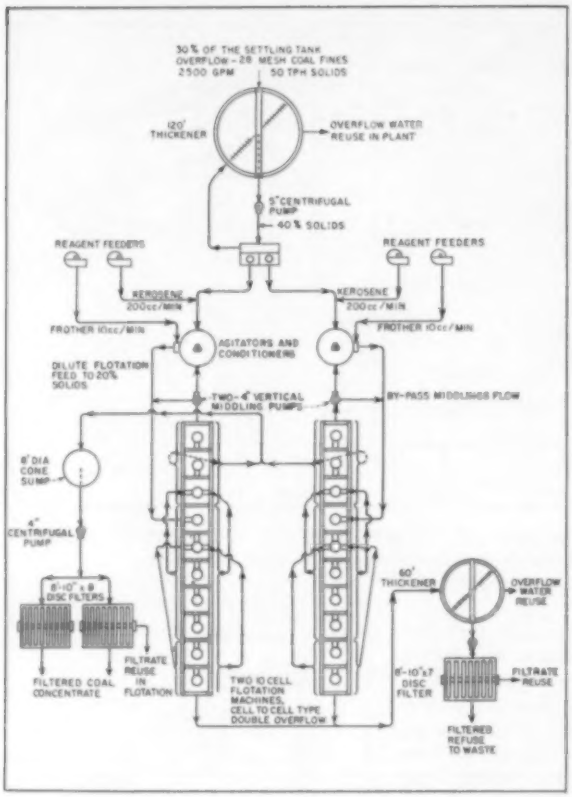
Gamma-ray equipment for gaging density of the magnetic solution as it flows also may be used for automatic control, as shown in an accompanying diagram. The unit actuates high- and low-limit control switches and in turn magnetic feeders and valves to keep density within the desired limits.



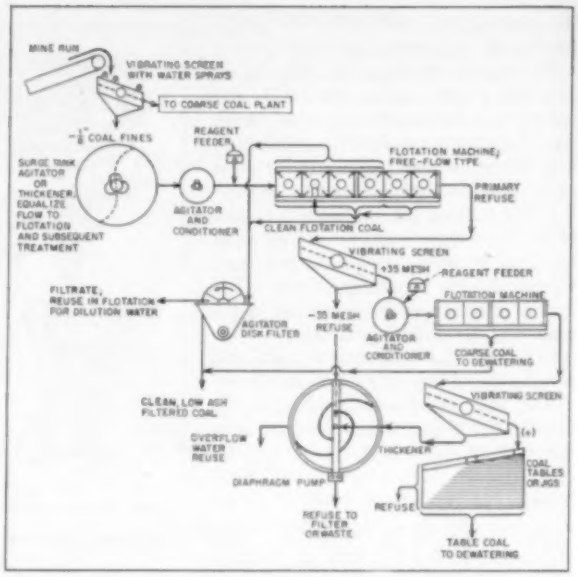
DENSITY MEASUREMENT with gamma-ray unit is new method of achieving bath uniformity with magnetite.

CIRCUIT SIMPLIFICATION—Keeping the medium-recovery circuit as simple as possible to minimize capital investment has been the subject of considerable investigation. One plant, using sintering-machine flue dust, which eliminates grinding and recycling at the sintering plant, has simplified the recovery circuit by converting the thickener to a sump; eliminating the magnetizing and demagnetizing coils with no apparent change in the operation of the cleaners; using one drum-type separator per vessel, the product of which is high enough in concentration for delivery to the medium sump without the need of a densifier; and using the separator tailings as spray water on the feed prewetting screens.

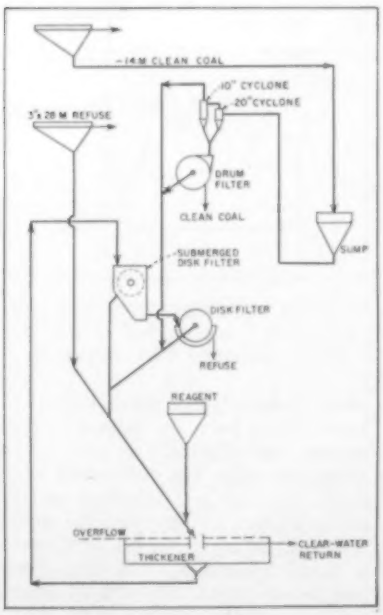
One heavy-medium unit is followed by an unloading screen dropping water and magnetite into a sump directly



COAL UP TO ¼ IN is treated in this flotation setup using machines designed for the service. Clean coal, refuse are filtered and thickened, and provision is made for final tabling or jigging of tailings.



FLOTATION SETUP for minus 28M coal using parallel flotation machines with middlings retreatment and following up by filtering both clean coal and also refuse fraction before final discharge to the bank.



CYCLONE DESLIMING is one feature of this fine-coal setup, which also includes flocculation in the thickener.

underneath from which the medium is recirculated. Density of the bath is adjusted by adding thickened magnetite produced by a separator and derived from the cone and refuse rinsing operations.

In still another design (*Coal Age*, July, 1958, p 81) the rinse-and-drain screen is incorporated in the final sizing shaker, as shown in the accompanying diagrams. Thus, all screening on the product side is accomplished with a single drive, and only one pump is employed in the medium circuit.

Bent-sieve screens, as shown in the cyclone-washing flowsheet previously discussed, are employed to unload water and medium in at least one plant abroad, materially reducing the investment in rinse-and-drain screens and magnetic separators.

Froth Flotation

As coal and refuse particles get smaller and smaller, their ability to move as desired through water or other washing medium becomes less and less until a point is reached where separation cannot be accomplished on the usual basis. The practical line of demarcation is somewhat indefinite, although the minimum so far suggested for heavy media, for example, is 1 mm, with ½ mm as a possibility. At that point, somewhere around 10M or less, a different principle of separation must be employed to get maximum efficiency with reasonable capacity.

Flotation achieves these goals. Facilities involved in flotation normally include a thickener or hydraulic classifier to size the feed, remove oversize, and so on; reagent feeders and conditioners where the reagent and the coal pulp are mixed and "conditioned"; and the flotation units themselves. The flowsheet also may be modified to include, for example, roughing cells preceding the final treating cells, retreatment units for a coal or primary tailing product from the primary bank of cells, or other modifications.

Two flowsheets showing, in one instance, the conventional setup for minus 28M coal, and in the other matte-type equipment for minus ⅛, are reproduced in the accompanying illustrations (*Deco Trefoil*, May-June, 1957). In the 28M installation, retreatment is achieved by returning the discharge of certain cells to cells earlier in the series.

The minus ¼ installation is an example of a relatively simple flowsheet which accomplishes efficient recovery at a low ash content. The coarser fraction facilitates subsequent dewatering. Primary refuse is screened at 35M, and the plus 35 is retreated in a secondary flotation unit, followed by screening of the tailings and final treatment on a table. All the refuse is collected in a thickener for water reclamation. The underflow may be filtered if required or desired.

Desliming, Desilting

Since leaving the extremely small sizes in the raw feed frequently reduces efficiency in cleaning the fine sizes of coal in addition to adversely affecting drying the trend today is to deslime or desilt prior to cleaning or drying. Desliming or desilting equipment includes cyclones, hydraulic classifiers, hydroseparators, bowl-type desilters and radial screens (*Coal Age*,, February, 1959, p 112) as well as conventional screens and other equipment. A fuller discussion of desliming appears in the "Dewatering and Drying" section later in this feature.

Air Cleaning

THE BASIS of cleaning with air is substantially the same as for cleaning with water or other mediums (see preceding section). Air, however, eliminates or reduces the drying problem, although it involves a dust-handling problem similar to the water-handling and clarification problem involved in wet washing.

High-ash and high-sulphur impurities are removed completely but there is practically no bone separation with air as the medium. The lower limit of cleaning with the most-used type of unit today is about 48M. There is no improvement in ash below this size but at the same time all the finer coal is available for mixing with the clean coal, meaning 100% recovery without the sludge and dewatering problems accompanying wet washing.

Air cleaners normally operate on a fairly closely sized feed and, as with water, the feed should be uniform in quantity and as nearly uniform in impurity content as possible. Moisture variations are particularly troublesome in air-cleaner operation.

PREDRYING — Present practice in eliminating the effects of high moisture and lack of uniformity in table feed is to predrying, and a number of plants recently built include predrying equipment of the heat type. At the same time, if total moisture in the mine product normally is high, the operator gains the sales advantage of a minimum moisture content in the shipped product. Increased moisture in the raw product, incidentally, reflects the growing use of water at the face.

To simplify the installation and eliminate duplication of equipment to supply air for drying and also for cleaning, one installation employs the drying air for cleaning as well. In this installation, a heat exchanger is employed to avoid passing the products of combustion through the cloth dust separator.

The majority of the air cleaners installed today operate on coal ½ in or less in size, though larger coal is treated. From the standpoint of the drying problem, washed coal over about ¼ or ½ in may be dewatered sufficiently for acceptance without special equipment—at least in many instances—which is in part the reasoning leading to the installation of combination wet and dry plants. And if mine conditions or mining practice make drying of fines desirable, it may be accomplished to the advantage of the air-cleaning process by predrying as previously noted. Normally, 2 to 2½% surface moisture in ⅜- or ¼-in coal is about ideal.

Most air cleaners now installed are three-product machines, and thus normally provide a middlings product for retreatment. The goal in this middlings production and retreatment is maximum efficiency in separation with minimum loss of coal values. Dedusting to remove up to 50% or more of the fines—usually 48M—adds significantly to normal air-cleaning efficiency.

Dust Collection

Equipment for dust collection includes the following:

1. **Large expansion chambers** into which the dust-laden air is routed to permit settlement. However, such chambers can trap only the larger particles. Smaller baffled units are employed, however, for scalping ahead of other equipment such as cloth collectors.

2. **Cyclone collectors.** These centrifugal units are a popular means of removing dust from air. Since single units handling large volumes are less efficient because of reduced air velocity, multiple and tandem units are offered, raising separation from, say, 85 to 95%, up to 98%.

3. **Turbo-centrifugal collectors.** Turbo-type units, usually termed "clones," offer the advantage of smaller size as a general rule. Like the standard cyclones, they are relatively inexpensive to buy, are easy to operate and are low-maintenance units.

FINE DUST—Even at 98% separating efficiency, the quantity of very fine dust that can still escape to the atmosphere can run up to several tons per day. To trap the most of this remaining fine dust, cloth or bag-type and wet-type collectors are employed.

Cloth collectors. Of the cloth-type collectors, the bag type was one of the first to be installed at coal-cleaning plants, normally with a shaking device to remove the accumulated dust. A more recent development is the cloth-screen collector, which provides larger capacity per unit of space occupied, is easier to inspect and maintain, and is provided with an improved cloth-shaking device. To prevent interruptions while the dust is being shaken off the units, dual-unit, or continuous cloth collectors may be installed, the air being directed alternately from one to the other.

Exhaust operation of dry-type equipment keeps the dust within the ducts and equipment in case there are leaks. Acid, abrasion and the like are factors to be considered.

Wet collectors. Wet-type collectors include the tumbler; a combination of turbo-centrifugal unit and water sprays; and the hydrostatic. All have the advantage of high capacity in relatively small space, in addition to a high separating efficiency as a result of the use of water, particularly in the tumbler and hydrostatic units, where the dust-laden air is passed through a water bath. Both units have no moving parts.

A new unit in the form of a cylinder comprises a wet-impingement screen, turning vanes, chamber in the walls to receive the air and water particles thrown out by centrifugal force, straightening vanes and an exhaust fan. One-tenth to one-twentieth the size with high efficiency is among the claimed advantages.

Retreatment

STEPS in the retreatment of coarse coal are as follows, starting with a product from the primary washer draw or a special middlings draw:

1. **Preliminary screening** of the product at 2 in or other limit.
2. **Crushing of the oversize** to the screening limit to release the impurities.
3. **Recirculation of the crushed product** to the washer or to a separate retreatment unit. Separate retreatment units are employed where several units handle primary cleaning or where, even after crushing, the recirculated product contains considerable material close to the washing gravity.

With the smaller sizes, particularly less than, say about ¼ in, where crushing is often less effective as a means of releasing the coal values, the entire draw product may be recirculated or retreated in a separate unit. This is particularly true in aircleaning coal under approximately ½ in. Two examples of middlings retreatment with air without crushing are shown in flowsheets accompanying the previous section on "washing."

The value of this method of enhancing cleaning efficiency and reducing coal loss is evidenced by the increasing use of separators designed to produce three products: clean coal, middlings and refuse. This has been particularly evident in cleaners of the heavy-media type.

Salvage

EXAMPLES of salvage operations include the following:

1. Crushing and washing of pickings, either in regular or special units to save coal values.

2. Picking out, crushing and loading separately for steam coal a bony product that might otherwise go to refuse.

3. Processing of roof brushings, track cleanings and the like to recover a regular or a steam-coal product. Normally, the production of such material should be sizable to warrant separate facilities.

Recovery from primary washer reject also, as a rule, involves preliminary screening to take out fines and crushing to release interbedded material, although the reject may be treated as it comes from the primary units. The latter, however, usually is less efficient and does not give as good a recovery.

Another form of salvage widely practiced in anthracite and to a limited extent in bituminous, is reworking contents of old refuse banks and silt ponds or dumps.

Salvage operations ordinarily are carried on with conventional screening, crushing and cleaning equipment. Exceptions include the use of rock-type screens and crushers, and extra-large draws on cleaners where mine material or pickings containing large percentages of rock are processed. One highly desirable characteristic of a salvage cleaner is ability to handle a wide range of feed in refuse content and quantity.

Clean-Coal Sizing

CLEAN-COAL SIZING or classification, is handled by both shaker and vibrating equipment, the latter having made substantial gains in this field as well as in the field of raw-coal sizing.

Accuracy

Aside from moisture and blinding, accuracy involves time the coal is on the screen surface, and also cloth or plate wear. Time on the screen brings in the question of breakage, or degradation, which increases with increased screening time, though as in anthracite, the hardness of the coal may permit a longer retention time without increase in breakage.

Other things being equal, sufficient time must be provided to permit the smaller sizes to work down and be separated out, and in turn this brings in the question of bed thickness. It should not be excessive if good screening is desired, and the smaller the opening the less the bed thickness should be if excessive length of screen is to be avoided. Where one of the products is screenings and the feed to the unit includes all sizes up to lump, depth of bed should not be more than 4 to 6 in, and screening efficiency and capacity may be increased by placing a large-hole relief screen on the slack section.

SCREENING EASE — The relative ease or difficulty of screening a certain feed at a certain size, which in turn is one measure of the screen area necessary for accurate separation, reflects in the main the quantity of near-opening material in the feed. If there is a substantial percentage of material at or slightly larger than the opening size, particles smaller than opening size find it more difficult to work down through the bed of near-opening material, and also there is a greater chance that particles only slightly undersize will be carried beyond the screening surface before they have an opportunity to go through. The difficulty increases as the size at which screening takes place decreases.

Screen Wear

Plate, cloth and wire wear reflect load, screening time, abrasive nature of the material, corrosion if the water is acid, and the material used in the screen. Where plain-steel plate is employed, increasing the thickness is one way of offsetting the effects of wear but brings a significant decrease in screening efficiency. Consequently, operators turn to bronze and alloy steels, with stainless coming rapidly to the front in recent years for the smaller sizes. However, as a general rule, stainless life must be 10 times plain steel life to justify its use for wear resistance alone, and therefore bronze or other alloys are favored for heavy plate. With round-rod or wire screens, or with special-profile bars, wear is largely on the top and consequently the period of reasonable accuracy is materially lengthened.

Small-opening punched plate must be relatively thin, both to facilitate the punching operation and because excessive thickness, as previously noted, affects screening efficiency. Consequently, additional support is required to prevent sag and wear. Bars under the plates are the preferred method. An alternative is the Peristeel-tread screen—a stepped-type unit in which the risers provide the extra support while the screening is done on the treads. Bars or other supports also are installed under the cloth on vibrating screens.

SPECIAL SCREEN OPENINGS — Elongated openings frequently are employed instead of round or square. Among the goals are: (1) increased screen capacity, (2) reduced blinding and (3) less breakage with friable coals. However, replacing conventional screens with long-opening units, with no change in the effective width of opening, normally increases the size of the through product.

A special form of screen is the lip type, usually with a greater width at the lower end of each opening. It provides a tumbling effect and this together with the type of opening, normally results in an increase in capacity of up to double or more. At some plants this characteristic has resulted in installation of lip screens to offset a condition of chronic overload. Incidentally, overloading severely affects screening efficiency. For maximum accuracy, feeders or other devices should be provided to insure uniformity in rate of feed to screens.

Use of elongated, lip and similar screens brings in the factor of separation by shape as well as by size. Consequently, the products are quite different in character, with considerably more flats in the underproduct with the elongated-opening units.

Blinding—Cause, Elimination

Blinding in coal screening occurs with all sizes but is particularly annoying and most affects efficiency with the smaller material. Blinding reflects in the main the percentage of particles near the size of the screen opening and especially, as the size of the coal decreases, surface moisture.

Additional factors tending to increase blinding include overloading and the presence of clay and shale mud. As a rough rule, a surface moisture of 6% will result in complete or nearly complete blinding at separations of ¼ in or smaller. At 2% or less, little or no blinding occurs.

Aside from blinding, moisture also tends to increase the inaccuracy of screening by causing small particles to stick to larger pieces. Where washing is done, one of the functions of sprays on classifying screens, in addition to opening up and agitating the bed to facilitate separation, is washing the fines off the large pieces and through the screen.

The building up of a film of moisture and packed fine material is held to be the major cause of blinding in fine-coal screening. Time is a second major factor. Rust and corrosion with plain steel also especially after the screen has been idle can cause major blinding difficulties, for a time.

Electrical heating is rapidly growing as a means of preventing blinding of screen cloth. Other methods applying to cloth, plate or both, include:

1. Alloy metals which resist wetting and film buildup.

2. Use of plate, wire and cloth impervious to or less subject to rusting and corrosion.

3. Use of large openings, though this brings in the risk of throwing more oversize into the through product.

4. More screen area or a lower feeding rate with higher moisture.

5. Screen heating. Heating cloth electrically is a common means of preventing blinding. Most screen manufacturers now offer designs applicable to practically all types of screens. In addition to eliminating blinding and its attendant effects, including the necessity of increasing screen opening, heating also offers two other advantages:

1. Increased screen output — up to 50% or more.

2. Longer screen life—up to 4 or 5 times in some instances. Also, some operators have found that they can get increased life with smaller wire and less costly cloth.

Heating, however, like other methods of preventing blinding, will not prevent wedging of near-size particles in the cloth nor clogging when the depth of the bed on the screen is greater than recommended practice.

Work abroad (*Iron and Coal Trades Review,* London, April 3, 1959, p 91) indicates that the following five steps, other than screen heating, may be helpful in eliminating or reducing blinding:

1. Increasing the amplitude to the maximum extent possible and with it the frequency. The aim is to employ enough energy to break the surface-tension bond between coal and wire.

2. Using wetting agents to reduce the surface tension, increasing the throughput "by 60%."

3. Covering the water with another liquid, such as a mineral oil. "With only 0.15% of domestic fuel oil it is possible to increase the screenability of moist materials by 60% or more."

4. Elimination of the enveloping liquid atomizing certain highly hygroscopic materials — quicklime, for example — over the coal.

5. Recycling coarse material over the screen to lower average moisture content.

More fundamental, perhaps, is mixing and blending to achieve uniform surface moisture or predrying of moist or wet material.

Degradation Removal

Screening out of small pieces resulting from breakage in processing, sometimes called rescreening, can take place at convenient points in the operation. Usually, however, it is done immediately ahead of the loading boom or chute, generally by a separate section of screen in the sizing shaker or in the chute leading to the boom.

Dewatering, Drying

BECAUSE THE SURFACE AREA on which moisture can collect increases rapidly with reduction in size, dewatering presents a greater problem with fines. As a rough rule, natural drainage will reduce the moisture on coal above ½ in and perhaps down to ¼ in to a point where there will be little or no freezing except in very severe climates. However, it may be desirable to reduce the moisture still further for the reasons set out at the start of this section. Below ½ or ¼ in, in the absence of some other form of treatment, freeze prevention requires specific dewatering methods and equipment.

Natural Drainage

Equipment employed in dewatering by natural drainage includes hoppers and bins; inclined and horizontal conveyors with screens in the bottom; perforated bucket elevators; and fixed screens. Fixed screens in flumes from washers to classifying screens, in fact, are widely used for unloading a large part of the water.

The fixed-screen principle for unloading or reducing excess water has been developed into special types of units both here and abroad. The launder screen recently developed for anthracite is made by placing 6-in-high partitions every 6 in along a chute or launder pitched at ¾ to 1¼ in per foot. Screen cloth is tacked over the compartments, which are drilled in the bottom to receive pipe bushings. Only a small percentage of the water and fines is removed in each compartment, resulting in more-even water distribution over the entire screen surface. Also, the bed is maintained in fluid condition, resulting in high screening efficiency.

"Radial" and "bent-sieve" stationary screens developed abroad are finding increasing use in the U.S. for various applications. The radial type is employed, for example, in removing silt from sand used in cleaning (*Coal Age,* September, 1956, p 78; February, 1959, p 112). It also can be used for screening and for dewatering prior to other drying.

The "bent-sieve" unit is employed for desliming and dewatering either by itself or in conjunction with other equipment. Both types of applications are shown in the cyclone-washing flowsheet in the preceding "Washing" section. Advantages of these stationary screens, and others doing similar jobs, are high productivity per foot of floor and screen space, low or no power requirements, and a substantial reduction in investment for final screening and dewatering facilities.

For coal larger than ¼ or ½ in, dewatering by natural drainage is quick and complete, and the product, as noted, normally will not freeze unless the cold is severe and lasting. Where the finer sizes are involved and freezing is a consideration, the problem becomes more difficult. However, natural drainage of coal as fine as 1/16 in and 28M to surface moistures of 10 to 12% is being achieved with flotation coal.

Mechanical Dewatering

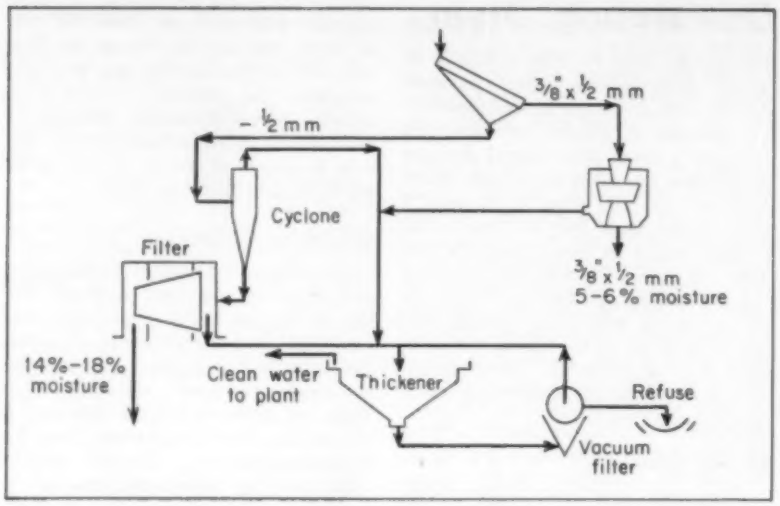
Omitting such processes as thickening and the like (see later section), mechanical dewatering is done by screens, centrifuges and various forms of filters, the latter including the high-frequency electrically actuated vibrating type. With all these units, the dewatering process, as with fixed screens, normally involves producing a through product which must be loaded wet, discarded or treated by other means. Also, the over-product, depending on size, and other factors, may be further processed in other types of equipment.

SHAKER SCREENS — Conventional shakers of course accomplish dewatering, but when dewatering is the specific goal the tendency is to go to special screens, usually flexible-board-hung or supported and operated at speeds of 150 to 400 rpm, with short throws of around 1 in. Anthracite shakers for both dewatering and sizing tend to operate at nearly conventional speed and stroke but with only a slight inclination, usually ¾ in per foot. For dewatering only, the speed is increased to 200 to 400 rpm and the throw is cut to 1 to 1½ in, especially for the smaller buckwheats.

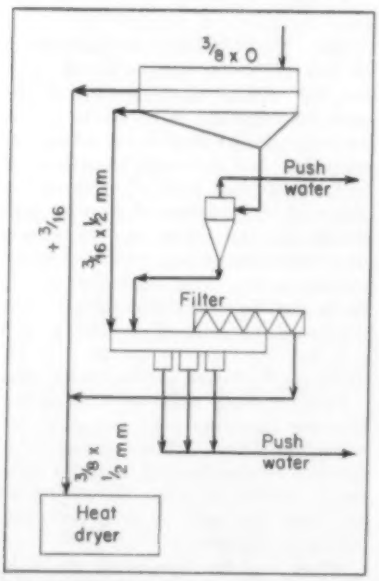
Plate or cloth may be used in dewatering the larger sizes, and plate also is employed for a substantial portion of the smaller sizes in anthractie. In bituminous, however, when dewatering at, say, 28M, the tendency is to use cloth, rod or wedge wire.

When used for dewatering, the shaker-type screen normally will reduce the surface moisture of sizes above approximately ¼ or ⅜ to 5% or less. When dewatering smaller sizes at, say, ½ mm or 28 M, surface moistures of as low as 3% have been obtained, but the range usually is 5 to 10% and higher.

VIBRATING SCREENS—When used within their limitations, vibrating screens provide real advantages in the field of dewatering. Initial, operating and maintenance costs are low, and a high removal of solids from wash water is achieved with a minimum of effort. Since operation in a nearly horizontal position is necessary, it usually is desirable to have a high operating speed and a stroke at an acute angle with the screen deck to facilitate the conveying action, which normally is slightly uphill.



SOLID-BOWL HORIZONTAL CENTRIFUGE supplements vertical unit in this circuit also including cyclone, thickeners and vacuum filter for refuse.



HORIZONTAL VACUUM FILTER in this flowsheet is preceded by cyclone. Filter product goes to thermal unit for final drying.

Width and length of screen should be selected for proper handling of the expected quantities of water and solids. Openings as narrow as ⅛ mm can be employed in some instances but the usual lower limit is ¾ mm. Special attention to keeping the width narrow enough to maintain a bed at all times is required. Dams in the center and at the discharge end help both in maintaining a bed and in promoting water removal through longer retention of the coal on the screen. However, dams should not be high enough to result in excessive bed thickness.

The bulk of the water should be removed on the first half of the screen for best results, and a bed of the requisite thickness should be formed as soon as possible to prevent excessive loss of the fine sizes. Unloading of as much water as possible before the coal is placed on the screen helps, and if fine sizes from some other unit are added they should be placed gently on top of the bed after it is formed. Size distribution of the primary feed should be such that it will form a bed.

Dewatering results reflect size of coal handled. Where the average size of the feed is around 5/16 in, a surface moisture of 5% normally can be attained, and in many instances much less. Final moisture increases with reduction in size up to 25% or more with, say, 28 or 48M material.

CENTRIFUGAL SCREENS – Now being offered for both dry screening and dewatering of the smaller sizes, the centrifugal screen provides results down to as low as 2 to 3% for coal approximately ¼ in in size in some instances, and normally around 5%.

CENTRIFUGAL DRIERS – Equipment of the centrifugal type commonly used in coal preparation includes the following:

1. Vertical units with transporting facilities. Positive transport results in equal centrifugal action regardless of size consist and prescreening is not necessary. Feeds of up to 20 to 45% surface moisture can be handled. If the percentage of extreme fines is not unduly high the unit will cut moisture in a ⅜ or ¼ x 0 feed to as low as 5 to 6%, with usually over 90% recovery.

2. Vertical units without transporting facilities, using water or vertical vibration to move the coal. As a result of absence of a basket, minimum screen-plate thickness is about 3/32 in, limiting perforations to about this size. Coal under around 28M usually should be removed from the feed. On ⅜ or ¼x28M, moistures of 5 to 6% can be attained with recoveries of over 75 to 80% as a rule.

3. Horizontal solid-bowl type – simplest of the three but less flexible. Recovery of ⅜ or ¼x0 is 95% or better. Final moistures are somewhat higher than with other types in many instances, though comparable results have been achieved with desliming. An accompanying flowsheet shows one method of employing this unit, as well as vertical equipment plus cyclones, thickness and vacuum filters in a circuit for ⅜x0.

In terms of actual water removed the centrifuge ranks high as a low-cost device, providing a total cost of between 5 and 10c per ton of cake. Degradation in operation must be expected. Means of reducing it include:

1. Introducing the coal evenly around the top of the basket at approximately surface speed, in turn a function of the number of vanes in the receiving element of the centrifuge.

2. Clearance no greater than particle size in machines with transporting facilities.

3. Use of rubber skirts instead of metal or concrete wear rings at the bottom to reduce discharge impact.

FACTORS AFFECTING CENTRIFUGAL RESULTS—The size of the fines fraction affects the results of centrifuging in much the same way as it affects the results of other forms of drying. As an example, solid-bowl units have produced surface moistures of 10 to 13% where the slimes have been included in the feed. In another plant, the same unit, with 60% of the minus 200M material removed from the feed, achieved a cake moisture of around 6%.

Maintenance also has a major bearing on the results of centrifuging. Proportions and clearances are carefully designed for maximum efficiency. Frequent maintenance, rather than letting renewable parts run to destruction keeps the moisture in the output at a minimum and thus increases acceptability without further treatment or makes the cost of subsequent thermal drying appreciably less.

FILTERS – With the increase in pressure to reduce stream pollution, and also as a result of the growing use of other types of mechanical dewatering equipment producing effluents containing fine material, there is an increased trend toward the installation of filters of the continuous-vacuum type. As a corollary, a solid-bowl centrifuge especially designed for the service, known

as a "polisher," is used for the same purpose.

Among the vacuum filters the drum type, and especially those with top-feed reservoirs, can handle coarser solids but require considerably more floor space.

A recent addition to the types of filters employed in coal preparation is the horizontal vacuum unit. Since it employs gravity, vacuum is not necessary to hold the cake in place and power requirements consequently are low. Aiso the operation is visible and controllable throughout the entire cycle. Its use in a cycle involving preliminary cyclone dewatering and final heat drying (⅜x0 feed) is shown in an accompanying flowsheet. Other flowsheets with desk-type equipment are included with a later section on "Water Handling."

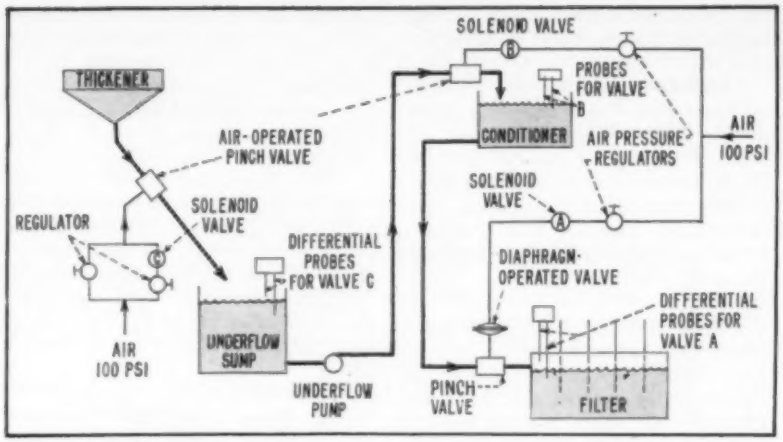
FINAL MOISTURES – With the vacuum type, flocculation of the fine-coal particles by means of caustic starch or some other agent increases filter capacity and reduces moisture in the final cake. However, some experience abroad has indicated that starch-type flocculants can result in difficulties in flotation where the filter effluent is recirculated. For a report on how flocculation increases filter capacity and how to select a flocculant, see *Coal Age*, December, 1957, p 74.

Final surface moisture of the filter product is held to reflect largely the moisture in the feed, the percentage of minus 200 to 325M material and the ash content of the dried product, though feed moisure apparently is less of an influence than the other two factors. Depending upon percentage of fines and ash, surface moisture in the product ranges down to as low as 15% and up to approximately 30%, with some exceptions both above and below. For a complete discussion of selecting and operating disk-type filters, including factors affecting filtration rate and moisture removal, see *Coal Age*, January, 1955.

AUTOMATIC FEED CONTROL – The accompanying diagram shows the automatic feed-flow control used at one plant to get a full cake at all times, prevent recirculation of solids, relieve the operator for other duties 90% of the time, and attain uniform cake moisture (*Coal Age*, October, 1957, p 106). Differential probes in the underflow sump, conditioner and filter tub control valves which in turn control slurry flow.

Thickening and Desliming

Since large volumes of water complicate the final drying job–whether in mechanical or heat equipment–and since very fine material decreases the capacity and efficiency of both mechanical and thermal units, the trend today is toward thickening or desliming, or both, in advance of drying, as well as in washing, as noted previously.



AUTOMATIC FEED-FLOW CONTROL for filters employs a combination of probes and valves to achieve uniformity in results.

THICKENING–Reducing the water load on the final drying units may be done by relatively simple means, common ones being fixed sieves or mechanical or electrical screens–usually both–ahead of the drying unit. For even greater water removal, plus also desliming, the equipment that may be employed includes settling tanks, drag tanks, thickeners and cyclones, which may be preceded–and usually are–by fixed sieves and operating screens for unloading.

The cyclone has the advantage of low cost and high flexibility. The settling tank also has the advantage of relatively low cost and simplicity but the degree of thickening may not be as great. Sedimentation in relatively still water is perhaps the ultimate in thickening, and is the province of the usual circular thickener. Although their first cost is relatively high, maintenance and operating costs are almost negligible and they produce clear water for reuse. To speed settling or to take care of conditions approaching colloidal suspension, flocculation may be employed. Starch is still considered the most satisfactory medium, though, as previously noted, it may result in trouble if the water is recirculated to flotation circuits. This trouble, however, is not encountered with synthetics, which are finding increasing use.

Examples of how most of the units previously mentioned an used are included in many of the flowsheets in this preparation guide.

DESLIMING–Removal of very fine material prior to further drying may be done as the first step in the fine-coal processing cycle, or directly before the material to be dried goes into said drier. Removing clay limes, as an example, ahead of froth flotation keeps reagent consumption low.

Desliming before processing at one new plant is done in two bowl-type desilters supplemented by rake-type classifiers. The desilters overflow minus 100M, approximately 80% of which is minus 200M. The coal then goes to the table plant, which is followed by four solid-bowl centrifugal filters, with a fifth as a spare. Filter effluent is returned to the clarified water circuit (*Coal Age*, September, 1956, p 78). The final dewatering step at this plant is performed by thermal driers reducing moisture to approximately 3%. How similar equipment is used at another plant is described in the February, 1959, issue, p 112.

Cyclone desliming is shown in a flowsheet in the preceding "Washing" section and also in a plan accompanying this section. The latter also involves flocculation (J. M. Vonfeld, AIME, February, 1956). The 1½ x 14M clean coal is screened at 14M, with the minus 14M being pumped to 20-in cyclones. The 20-in cyclone overflow then is deslimed in the 10-in units. Underflow from both is filtered in a top-feed drum unit and loaded with the clean coal. Effluent from the small cyclones and drum filter is sent to the thickener with minus 28M refuse, added to improve filtration of the thickener underflow.

The thickener feed is treated with causticized corn starch to increase solids settling rate and improve clarity of overflow water. The thickener underflow goes to a submerged disk filter whose purpose is to permit withdrawal of the underflow with a fairly low solids content without influencing the operation of the final disk unit. This final filter is able to maintain a relatively thick, dry cake–disposed of with the coarse refuse. There is no bleed, and the overflow from the thickener is returned to the

table plant as dressing water. It is clear, facilitating observance of table operation.

Classifiers of various types, also conventional screens and other equipment, may be employed for desliming. At one plant (*Coal Age*, September 1957, p 76) desliming ahead of centrifuges is accomplished by a horizontal vibrator with ⅛-in screen receiving ¼ x 0 from a setting tank. Screen underflow returns to the tank.

WARM-WATER PROCESSING – Water is easier to shake or spin off when warm. Advantage is taken of this fact at one plant (*Coal Age*, December, 1955, p 70), where dust is removed from the dryer exhaust by a combination of cyclone collectors, and water sprays are used to cut down the speed and volume of the exhaust to atmosphere. Four thermal dryers each exhaust 50,000 cfm at 200 to 250 F. The exhaust carries with it 14Mx0. Two cyclones are provided for each of the four dryer exhausts, after which the gases go to a concrete duct leading to a silo chimney.

Sprays in the concrete duct reduce gas temperature from approximately 180 down to 110 F. The warmed water, with its temperature raised about 45 F, is returned to the fine-coal washing circuit, raising its temperature by up to 13 F in winter. This warmer washing water and resulting warmer coal facilitates mechanical dewatering, apparently by reducing surface tension.

Heat Drying

Heat drying is about the only way to get surface moistures of as low as 2 to 3% consistently, particularly with the finer sizes.

DRYER TYPES – Types of heat dryers used in coal mining are:

1. Rotary, with either inner and outer shells, or an outer shell with lifting vanes inside.

2. Reciprocating screen, which also acts as the carrying medium. In most instances, the gas is pulled down through the bed and the drying action is of two types; evaporation and, to some extent, mechanical as a result of the screening action and the scrubbing action of the gas. When the gas flow is interrupted by an appropriate valve and then is resumed, squeezing also takes place. As the coal gets finer, evaporation becomes relatively more important, and consequently, fine-coal screen driers are designed for longer coal retention as a rule. New designs include a step between the two screens to turn the coal over.

Top size varies from as low as 1/8 with the fine-coal units up to 2 or 2½ in. Depending upon size of the unit, and also the size of the coal, capacities of screen-type driers normally range from 25 to 125 tph of dried product.

3. Cascade, in which the coal flows down in steps. Units employing the cascade principle usually are fitted with revolving shelves or trays in a round vertical shell. The coal is plowed or otherwise moved from one tray to the next in the drying process, which is largely based on convection. By tempering the incoming gases and by mixing them with the circulating air in certain types, the gas temperature at the point of contact with the coal can be cut to as low as 150 F.

Depending upon type and design objectives, dryers of this type handle coal with a top size ranging from ¼ or ½ in up to 2 in, with some more suited to handling certain size fractions, such as, 2x½.

In another unit employing the cascade feature, coal is carried up on conveyor pans, or louvres, cascading down repeatedly while it works its way from one side to the other. Top size ranges from ¼ or ⅜ up to 1 in.

4. Conveyor or carrier, in which the coal is moved through a hot-gas chamber on a perforated carrying strand or a wire-mesh belt. One type provides two stages of drying with both up- and downdraft gas flows.

5. Suspension, also known as "flash," in which the coal is introduced into an upward-flowing gas stream. These dryers are widely used on coal ½ or ⅜x0—sometimes down to 10M or less. One recycles part of the stack gas to the furnace to keep down oxygen content and maintain an inert atmosphere in the dryer. In a second type, part of the dried product can be recirculated if feed moisture is naturally high or as a result of a high percentage of fines. A special trap is available for the latter unit for friable coals. Both also include provision for burning the dust from the cyclones or secondary separators.

6. Fluidized-bed, in which the coal is dried in a reactor in a fluid state. Though originally developed for a top size of ⅛ in, the units now are employed on sizes up to 1¼ or 1½ in. In the first installation, with a feed of 85 tph, 3/16x0, 11% surface moisture, the final product averaged 2% surface moisture with a fuel consumption of 1 ton.

DUST SUPPRESSION—Dust is a problem with practically all heat dryers, and particularly with those handling the smaller fines. Cyclones are the first line of defense and may be supplemented by bag-type collectors, wet collectors and water-spray systems (see "Air Cleaning"). High temperatures and high moistures in the spent gas have militated against the use of bag collectors in some instances and resulted in adoption of wet or wet and dry (tumbler-type) collectors.

DRYER SAFETY—Ten recommendations by the USBM for promoting safety in the operation of heat dryers (R.I. 5198) are:

1. Good housekeeping should be stressed to prevent spread of combustible dust and eliminate ignition sources. Adequate vents should be provided, not only on cyclones but on other equipment and in the main structure of the plant.

2. Automatic controls – preferably with alarms—should be provided to shut down equipment if the temperature rises excessively, coal feed is interrupted or gas flow is interrupted.

3. Moisture content of the coal feed to the dryer should be maintained at a uniform level.

4. Temperature charts should be carefully watched and dryer operators should not tamper with equipment or controls.

5. Controls, valves and others sensitive parts should be inspected frequently.

6. Equipment should not be operated beyond rated capacity and definite upper limits should be placed on permissible inlet and outlet temperatures and the rate of coal feed.

7. Scrubbers and collectors should be placed beyond the cyclones to prevent excessive discharge of dust.

8. Adequate fire protection and fire-fighting equipment should be maintained in the drying plant.

9. Long ducts, and especially horizontal ones. should be avoided to minimize ignition hazards and reduce surfaces on which fine coal can accumulate.

10. All dryers. conveyors and other dust-producing equipment and transporting machinery should be made as dust-tight as possible and operated to prevent dust leakage.

Crushing

ALTHOUGH CRUSHING or breaking for market purposes can take place in the preliminary processing, as in reducing the top size in the mine-run feed to a certain dimension, the majority involves specific sizes after hand picking or other cleaning and the goal usually is the production of stoker or other smaller sizes. An exception is anthracite, where practically all of the breaking is done in one or more stages before the coal goes into the cleaning units.

In bituminous plants, a favorite place for cleaned-coal crushing equipment is between the top and bottom strands of the mixing conveyor. This permits a wide flexibility in the sizes that may be run to the crusher, and also provides a convenient means of getting the crushed product back to the loading point, es-

pecially when the product is loaded without further sizing or other treatment.

Crushing may be—and frequently is—a part of a breaking and rescreening cycle for the production of double-screened stoker or other sizes, such as pea (see "Rescreening").

FINES LIMITATION—A major goal in clean-coal crushing operations—or, in preliminary breaking for the same purpose—is reduction to the proper size without excessive production of fines. Crusher design is one answer, and types and models now available permit good attainment of this objective. Operation is another answer and, among other things, involves stage crushing with rescreening between each stage. Some plants use as many as three or four crushers in series with vibrating screens between to unload the fines, which otherwise would result in increased grinding and pulverizing.

Rescreening

THE VIBRATING SCREEN, normally receiving its feed from the main sizing shaker is the most-used type of rescreening unit in the bituminous fields. Air also has been used for dedusting at Ivy, 48M, in making the smaller stoker sizes. Rescreens also are quite commonly hooked up to receive material from cleaned-coal crushers when the natural output of the mine is not sufficient to meet stoker and other specialty demands.

Mixing, Blending

MOST of the mixing is done in the old reliable mixing conveyor. Unless crushing is introduced into the circuit, the mix is a natural one—in other words, the sizes in the mix are present in the percentages that naturally come from the final sizing screen.

"Prescription" mixing is a relatively new method of achieving a size consist in line with the customer's desires. A major advantage is that the consists can be absolutely accurate and also absolutely uniform.

Prescription mixing normally is limited to the smaller sizes designed for industrial or domestic-stoker use. It involves placing the various sizes in separate bins. The sizes may be as they naturally come from the sizing units, or they may be produced in part or entirely by crushing and rescreening. Mixing normally is achieved by feeding the sizes onto a gathering belt ending in a boom section. The rate at which the sizes are fed out of the various bins establishes the percentages in the mix. This rate may be adjusted by adjusting gate openings, but is considered less accurate than special feeders equipped with variable-speed drives.

Dustproofing

THE PRINCIPAL MATERIALS used for dustproofing coal are oil, calcium chloride and special chemical compounds, usually containing calcium chloride with other substances added. Calcium chloride and other materials pick up water from the air and thus provide a moist surface to which the dust adheres. Corrosion-inhibitors may be added to the chemical-type dustproofing agents to prevent possible attack of metal firing equipment and coal-handling parts.

Spray oils for dustproofing are available in a wide range of characteristics to fit the job being done. Equipment for applying them includes both heating equipment for spraying hot, and high-pressure atomizing, or "cold-oil" equipment for spraying cold. With the hot-oil systems, the oil-carrying lines may be paralleled by heating lines carrying steam or hot oil to keep the oil at the proper temperature.

QUANTITY AND TYPE—Quantity of material necessary to achieve a desired degree of dustproofing depends upon both the size and type of coal being treated. Since the treatment is a surface job, and the surface to be treated increases as the size of the coal decreases, more material must be applied to the finer sizes. Porosity and other mechanical characteristics of the coal also influence both quantity and type of dustproofing material. With some very porous coals for example, good treatment with an economical quantity of petroleum-base material requires going to a very-high viscosity to prevent absorption of the material into the interior of the coal. Most of the high-volatile coals, however, may be treated satisfactorily with oils having a viscosity of around 200 deg.

APPLICATION – For maximum effectiveness with a minimum quantity of material, dustproofing material should be applied while the coal is in the air. Use of properly designed hoods prevents waste and insures maximum treating efficiency. Normally, such hoods are placed at the ends of loading booms or chutes, but they may also be placed over conveyors and other equipment, particularly those handling the larger sizes. The proper design of nozzle and the proper temperature at the point of application are key factors in the use of hot oil, and nozzle design is likewise important with other types of material to insure good treatment with minimum material quantities.

Regulation of material flow to the flow of coal may be accomplished by such steps as paddle-controlled valves at the ends of booms and chutes. The position of the valve is controlled by the thickness of the coal stream and in turn increases or decreases the flow of dustproofing material, preventing both overtreatment and undertreatment.

Freezeproofing

WHERE HEAT DRYING is not the practice and mechanical drying does not provide sufficient moisture reduction to prevent freezing, the coal may be treated with chemicals or oil. Such treatment usually is required with slack, screenings and other small sizes. The need for treatment is affected not only by the climate encountered but by industry custom and customer preference.

Salt and calcium chloride, usually applied dry, are the two main chemicals used for freezeproofing. The quantity depends upon the expected temperature and the moistness of the coal. For calcium chloride, the Calcium Chloride Institute offers the following guide:

	Lb CaCl per Ton at Specified Temperatures, Deg. F.			
Moisture	+32 to +15	+15 to 0	0 to −15	
3%	3.0—4.5	4.5—6.0	6.0—7.5	
6%	6.0—9.0	9.0—12.0	12.0—15.0	
9%	9.0—13.5	13.5—18.0	18.0—22.5	

Chemicals may be thrown into the car by hand or may be dispensed by mechanical feeders into the coal stream as it is loaded. The latter normally provides more uniform and more accurate treatment.

Oil is finding increasing application as a freezeproofing agent. One operation, as an example (*Coal Age*, February, 1956, p 75), uses an 80-sec oil at the following rates: ¾x0 centrifugal carbon, 6 qt per ton; 4x2 or 2x1¼ crushed to 1¼ or ¼ in, 2 qt; 1⅞x28M mix, 3.4 qt at a cost of 0.084c per ton. In loading coal under 1¼ in in size, the inside of every hopper is sprayed with 6 gal of oil for a 50-tonner and 7.6 gal for a 70-tonner at a cost of about 1c per ton.

Loading

ANTHRACITE is loaded into railroad cars almost entirely from storage pockets, reducing the number of loading tracks to one or two for many plants. Early bituminous practice was to provide a track for at least each major size. Now, as in anthracite, the bituminous trend is toward loading on as few tracks as possible. Methods of reducing the number of loading tracks to a greater or lesser degree include:

1. Storage pockets. Such pockets, receiving coal by conveyor, may be above or below the normal loading point. Thus,

a second size—stoker as an example—can be loaded.

2. Two-way chutes. Dual conveyors, as an example, deliver two sizes to two-way chutes, one for each track. By combining through gates, the number of sizes to the two tracks can be increased to three.

3. Elevated shuttle belt. Where only one size is loaded, or where storage facilities are provided for one or more additional sizes, loading of up to an entire shift's run can be done without moving a car once the trip is set in (*Coal Age*, March, 1953, p 94; October, 1957, p 76).

4. Automatic shuttle belt. In one example of the use of this equipment, the belt is mounted between parallel tracks. Empties are placed on one of the tracks and the belt travels from one to the other, loading them in sequence. It then switches to the parallel track and works back while the loads are being replaced with empties. If there is a gap the belt will continue to travel along one side and cross over to the other to try to find an empty. If it can't it shuts the plant down—automatically—until empties are placed.

CAR HANDLING – Mechanical retarders provide positive control of car movement in loading, and there is a growing trend toward the use of motorized equipment, including special hoists which permit pulling a car back uphill if desired, or moving it back and forth several times to load the coal in layers.

Hoist-type retarders, incidentally, save overshooting and runaways, and consequently eliminate delays ranging from several minutes up to, where a column may be knocked out, several days.

Automatic dropping and loading of cars is now coming into the picture. At one of the first installations (*Coal Age*, June, 1958, p 94) the system involves hoists with double ropes and sensing switches to control car movement, transfer of coal flow from one to another, and uniform loading without the attention of an operator.

Gravity and electro-pneumatic retarders are employed in another system with varying degrees of automaticity. In one such installation (*Coal Age*, February, 1959, p 118), some 720 tph is loaded on one track. At another (*Coal Age*, July, 1959, p 80) one man at the dump controls the spotting and loading of some 20 to 30 cars an hour on four tracks.

Clean-Coal Storage

Stockpiling clean coal is a growing practice at bituminous mines, as well as anthracite. The favored place is on the ground, though some silos and bins are employed. Capacity ranges up to several thousand tons. With large stockpiles, belt equipment is used in almost all instances for both stocking and reclaiming, with the reclaiming unit usually placed in a subway under the stockpile.

Piles may be single conical, laid down by a fixed-discharge conveyor; curved, laid down by a pivoting stacker conveyor; double conical, laid down by separate piling booms fed through a flygate, or by a reversible stacking belt; or long and narrow, laid down by a belt with traveling tripper. Lowering spirals or ladders are employed to reduce breakage where piling booms are not employed.

Truck Loading

It is possible to load trucks over the tracks or by chutes brought out from the plant but this, among other things, makes it impossible to service trucks except when the plant is running. Consequently, the usual practice is to provide bins or pockets for sizes sold to truckers. Spiral lowering chutes prevent breakage in filling bins holding the coarse sizes, and degradation in handling through the bins is removed by fixed screens in chutes, or by small shakers or vibrators.

Late truck-loading plants include, in the bituminous field, a multiple-silo installation in which the coal is distributed to the pockets by a pivoted elevated belt, which is swung on a curved track from one pocket to the other for filling purposes. Trucks are loaded through chutes.

In the anthracite field, a six-bunker plant is designed so that all operations are conducted by two men and accurate dispensing of orders is controlled by presetting dials to control flight feeders delivering at rates up to 5 tpm (*Coal Age*, January, 1954, pp 68-69).

Barge Loading

Barge-loading plants fall into about five classes, as follows:

1. A simple dock from which trucks dump into the barge at times when water conditions permit.

2. The stationary-chute type, which is simple and low priced and works well where river fluctuations are not too great and banks are steep.

3. Elevating-boom type, with barges moved back and forth in the river beneath. The elevating boom allows more loading time if river elevation changes greatly. This type is advantageous where the bank of the river is considerable distance from the channel and the elevating boom and conveyor belt can be combined for travel across the flood plain.

4. Floating-barge type, with the loading boom mounted on a floating, or spar, barge and pivoted for easier loading. Requires a steep bank or fill to permit retraction and extension of the main conveyor with changes in water level.

5. The tripper-conveyor type, in which the barges are stationary and the loading chute moves back and forth to load and trim. Nothing has to be done to the barges but load them.

For examples of most of these types see (*Coal Age*, December, 1956, p 58; also October, 1956, p 60; June, 1957, p 74; January, 1958, p 76).

TRAMP-IRON REMOVAL—Removal of tramp iron is handled at a number of plants, even though all sizes are washed, by suspended magnets or magnetic pulleys at the point the raw coal enters the plant. If washing or removal in the raw-coal stage is not practiced, iron removal should be done in the loading stage, especially with coal designed for stoker use. Facilities include magnets designed for use in the bottoms of loading chutes, as well as other types of units.

DEGRADATION REMOVAL – See "Clean Coal Sizing."

Water Handling

QUESTIONS involved in water handling at plants cleaning by wet methods include:

1. Fresh-water supply and treatment for plant use.

2. Clarification and recirculation of process water.

3. Final disposal where circuits are or cannot be closed.

Makeup water requirements vary with the type of circuit. In a fully closed circuit, where sprinkling at the face results in an average of 5% surface moisture on the raw coal, which is the same as the average for the shipped coal, it can be seen that fresh water cannot be added. Normally, the only clear-water applications would be on pump glands and certain other essential applications. In an average plant, under these conditions, makeup water might well be only 50 to 75 gpm. In an open circuit, it might well be several times that minimum.

Sources of makeup water are:

1. Deep wells.

2. Surface water from lakes, ponds and streams, or from reservoirs made by dams to catch surface runoff.

3. Mine water, if available.

TREATMENT – Water from deep wells normally can be used without treatment. Mine water, on the other hand, may be quite acid, though there are exceptions. Surface water may or may not be acid, and may at times be contaminated by mud. Some authorities hold that the pH value of the water in

the plant circuit should be between 8.0 and 8.5.

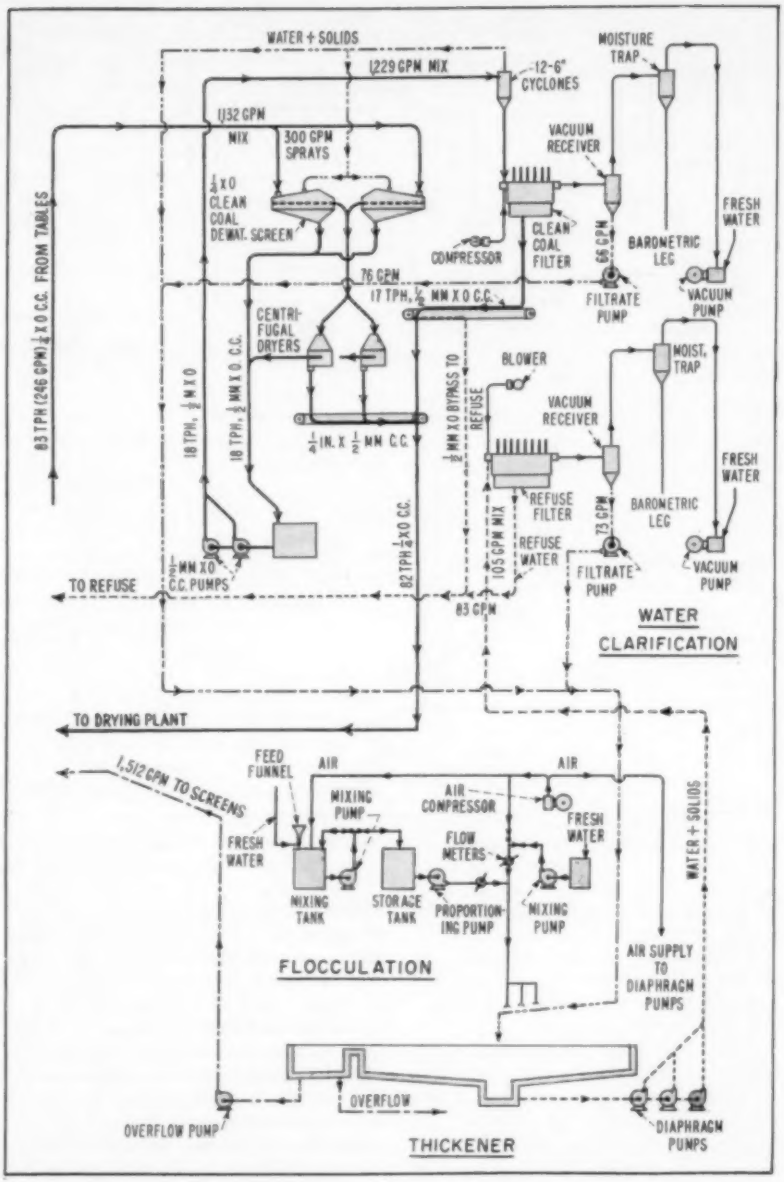
Other operators, however, feel that slight acidity is not objectionable. However, if the water is very acid, treatment with lime or soda ash is in order. Treatment permits plain steel for example, to be used instead of alloys, resulting in substantial savings in cost of equipment and materials, in replacement labor and in shutdown time. Even if the makeup is only mildly acid or neutral, acid may build up in the recirculated water and need treatment for that reason alone. Automatic equipment is now available for treating water efficiently and at minimum cost.

Unless there is an assured minimum flow adequate for plant need at all times, storage should be provided to tide the plant over periods of reduced flow.

Handling Wash Water

Stream-pollution regulations and the need, in many instances, for decreasing the loss of good coal to the refuse have resulted in major activity in the processing of wash water. A third reason for processing is to prevent the buildup of solids in water recirculated to washing units, since excessive buildup may materially affect the gravity of separation and consequently cleaning results. Available data indicate that many preparation men regard a solids content of more than 15 to 20% as excessive, while some try to keep it under as low as 5%.

Closed circuits frequently are mentioned as objectives in water handling - and are practicable in some instances though not in all. Reasons for circuit closing include: (1) elimination of discharge to streams, (2) reducing makeup water to that required for pump glands and other essential uses, (3) recovery of coal and (4) recovery of medium. As a corollary of closing, however, it is necessary to remove at least part of the solids, especially if clay and mud are present, to prevent solids buildup and a change in the gravity of the bath.



WATER-CLARIFICATION CIRCUIT at one new property involves a combination of cyclones, thickeners, centrifuges and vacuum filters.

THE WHY OF BLEEDING—Closing a circuit may either be impossible or not desirable, however. If, as previously indicated, moisture on the coal leaving the plant is equal to that entering the plant, the quantity of makeup water that can be added without bleeding is nil. Thus, even gland-water requirements, if included in the water circuit, can force bleed under some circumstances. Some circuits, however, have been closed successfully.

Practice and field custom also may result in bleeding of some to considerable quantities of wash water. It may, as an example, contain large quantities of high-impurity fines that would be difficult to clean. And under some conditions, it may be necessary to feed excess fresh water into the system for essential services, even if it is not required to rinse off clean coal and improve appearance as it might be in some instances.

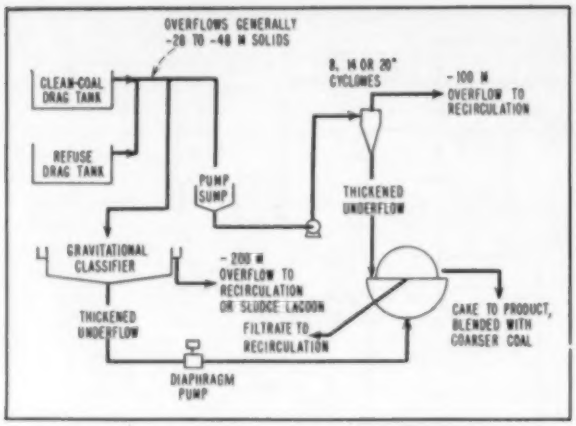
Also, complete closing in the sense of allowing no escape of either coal or water may become impossible if certain steps are considered desirable in the preparation process—for example, desliming at 325M. The slimes must go somewhere and it is not always practicable to prepare them so they can be put in with the clean coal or the refuse.

Since bleed therefore becomes necessary in the majority of instances, the sludge pond also becomes necessary. Examples of its use include:

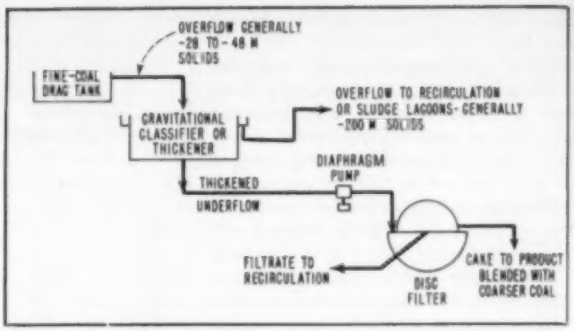
1. **Effluent containing minus 100M** flowed to 7-acre pond for solids settlement and subsequent reclamation by dredge and flotation; clear water returned for plant use because natural supply is not always sufficient.

2. **Settling pond** used to clarify waste water for water reclamation and to conform to antipollution regulations; recirculating water clarified in 125-ft thickener.

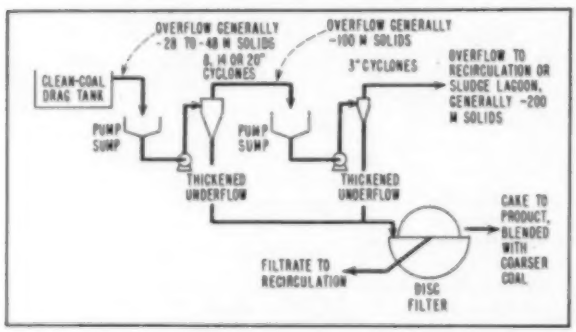
3. **Preliminary clarification** with settling tanks and large and small cyclones done primarily for coal recovery; some 98% of the minus 200M material bled



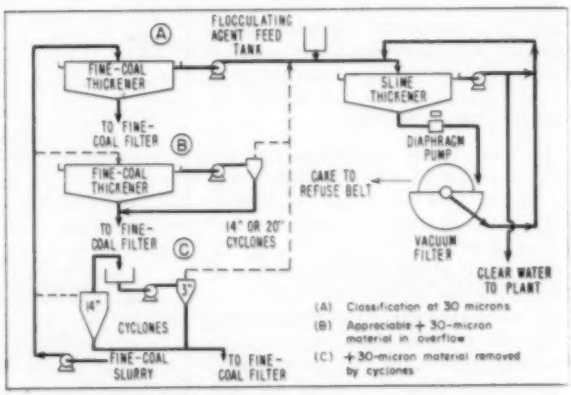
SOLIDS REMOVAL from wash water by flocculation and filtration, with variations to meet varying conditions.


OVERFLOW GENERALLY
-28 TO -48 M SOLIDS
FINE-COAL DRAG TANK
GRAVITATIONAL CLASSIFIER OR THICKENER
OVERFLOW TO RECIRCULATION OR SLUDGE LAGOONS- GENERALLY -200 M SOLIDS
DIAPHRAGM PUMP
THICKENED UNDERFLOW
FILTRATE TO RECIRCULATION
DISC FILTER
CAKE TO PRODUCT BLENDED WITH COARSER COAL

VACUUM FILTRATION with gravity classifiers or thickeners for preliminary classification of the feed to the unit.



VACUUM FILTRATION with cyclones for preliminary classification of feed.



VACUUM FILTRATION with gravity thickeners and cyclones for preliminary classification of the feed before filtration.

off to pond to keep solids content of the system constant.

4. Vibrating screens followed by settling pond prevents clay buildup and enables plant to comply with anti-pollution regulations.

5. Settling ponds used to keep solids content of circulating water under 15% at plant using thickener, cyclones and vacuum filters. This is achieved by bleeding system when solids buildup requires it. Average solids content of bleed water is 17 to 20%.

SOLIDS REDUCTION—The goal in this operation, in contrast to fairly complete removal to meet pollution regulations, for example, is keeping the solids content of recirculated water to a reasonable figure; not over, say, 15 to 20%. The old-reliable conical or drag-conveyor settling tanks are standard equipment units for this purpose.

Examples of how sludge ponds may be used for this purpose are summarized in the preceding section. Other systems and equipment include the following example:

Settling tanks to accomplish primary recovery of coal, with overflow to two batteries of large and small cyclones. Small cyclone overflow returned to system but part containing 98% minus 200M is bled off to keep solids content of system down to 10%. Underflow from both cyclones goes to disk filter for solids recovery prior to heat drying.

FLOCCULATION — Where natural settlement is depended upon for removing solids from wash water, results reflect the size of the material, the time provided for settlement, and the degree to which disturbance can be reduced. Flocculation of the material promotes settlement, and some types of thickeners are built to permit flocculation along the settlement.

SOLIDS REMOVAL—Complete removal of solids may be desirable for two reasons: (1) salvage of good coal from the wash water, or (2) conformity with pollution regulations. Where coal is concerned, the same installation ordinarily accomplishes both results. Where refuse is involved, the only goal is meeting stream-pollution regulations.

Settling ponds, where space is available, are perhaps the simplest method of attaining sufficient solids removal to conform to pollution regulations. In some instances, they may be the cheapest, though not always. Their construction involves some expense, and if the capacity is limited they must be cleaned out from time to time. With ponds also, any fines that reach them, if of good quality, are either lost or can be recovered only at some added expense. Consequently, there is a trend toward extracting at least part if not all of the solids from the water before running it to the pond.

Equipment for accomplishing some solids removal before discharge to the pond may be merely the old reliable conical or drag-conveyor settling tank. Other units are thickeners, hydraulic or nonhydraulic classifiers, cyclones, and filters of various types. Combinations also are employed to meet specific conditions.

FILTER CIRCUITS—Three variations in a solids-removal flowsheet involving flocculation and complete closing of the circuit (*Coal Age*, January, 1955, p 76) are shown in an accompanying illustration. The goals are economical operation and removal of the solids so that they can be handled the same as any other solids, whether coal or refuse. Variation A is recommended where the fine-coal circuit includes a gravity classifier effectively classifying at 30 microns; Variation B, where gravity classification is such that an appreciable quantity of plus 30-micron material is found in the overflow; and Variation C, where the equivalent

of two-stage cyclone concentration is employed.

Three water-handling systems based on filters for final recovery of the solids also are shown in the accompanying illustrations. They are suggested for use where clay slimes are not excessive and closed-circuit operation can be obtained by filtration, or where the large slime fraction is bled off to a sludge pond. The three systems involve:

1. **Cyclone classifiers in conjunction with gravity classifier or thickener** delivering thickened underflow for filtration.

2. **Cyclone classifiers in conjunction with filters.** The two-stage system shown may be employed (1) where solids under 100M are too high in ash to be included in clean coal and (2) all underflows from both stages are filtered as clean coal. A buildup of minus 100M in the circulating water is prevented in both instances.

3. **Thickeners and cyclones** for preliminary concentration. Better filter operation is one of the advantages.

How filters are used in a circuit also including dewatering screens, thickener with flocculation, and cyclones is shown in another illustration. The system functions on ¼x0 and the final products are clean coal, refuse and clear water to the raw-coal shakers or to overflow. Thermal drying completes the job (*Coal Age*, October, 1957, p 76).

WATER CIRCULATION – Head tanks with automatically controlled pumps provide a uniform head on washing equipment, with consequent increase in the efficiency of separation, particularly with jigs.

Handling of casual and spillage water is simplified by proper design of the basement floor, which should be equipped with drains leading either to the pond or to a recirculating-water sump. Cleaning up by washing down is facilitated by such construction.

Sludge Recovery

NORMALLY, water clarification and the recovery of fine coal go hand in hand, although if clarification only is the goal the material may only be routed to the refuse bank, particularly if it is refuse in fact. However, the percentage of material finer than, say, 10 or 28M, may be substantial at many plants and may warrant recovery for its own sake.

The equipment for recovering sludge from wash water, as noted in the preceding section, includes: settling cones and tanks, and thickeners and filters, along with hydraulic and nonhydraulic classifiers and cyclones. Cleaning equipment includes flotation units and special fine-coal washers, followed by normal dewatering and drying.

The preceding envisions recovery of the sludge as it is produced in the plant. Another form is recovery from old silt or sludge ponds or banks. Recovery equipment includes conventional shovels and also floating dredges. At some installations, the final step consists of drying. A modification, where the nature of the material warrants, is centrifuging to throw out the fine impurities and then heat drying. Where cleaning is considered desirable, a number of large plants have been built for froth flotation.

Refuse Disposal

THE DUMP TRUCK has taken over a large part of the refuse-disposal job in the coal industry today. Its advocates cite low cost and maximum flexibility, especially where it does not have to surmount too-heavy grades. The aerial tramway lends itself not only to disposal in what might be called normal territory but also to taking refuse across hills into neighboring valleys and the like. The side-dumping or revolving larry, in addition to ordinary situations, also is used to build out from hilltops or hillsides from bins fed by belt conveyors, tramways and the like.

Pumping of refuse is growing, though the question of taking care of the water to prevent stream pollution comes in. In some instances, it has been possible to pump into old mines or worked-out sections. The pumps will handle rather large pieces but normally pumping requires crushing to a top size of 2 or 3 in. Usually top size is held to not over ¾ or 1 in by prescreening or crushing, keeping down line velocity and cost.

Even where pumping is not involved, it may be economical to crush, particularly where large rock is involved. Jaw or gyratory crushers may be indicated under such circumstances. Benefits of crushing include easier handling, a more compact pile and greater ease in maintaining a running surface where trucks are used.

Where refuse output is large, and especially where trucks and similar equipment are employed, a bulldozer for spreading and compacting may pay off.

FIRE PREVENTION—Prevention of firing of refuse dumps has been the subject of considerable research in recent years, and the spread of automotive haulage has made possible new and effective methods of piling, compacting and sealing refuse to practically eliminate firing. One method of layering, compacting and sealing against air is described in *Coal Age*, June, 1951, p 91. Development of the method also was accompanied by steps to extinguish an old fire by stepping, trenching and filling and covering with earth as conditions dictated.

Power

VOLTAGE – Accepted voltage for most of the stationary motors in preparation plants is 440, leaving in most instances only the question of whether 2,300 V should be used for certain large units, such as pumps, crushers and the like. A rough rule is that motors of 100 hp and larger should be 2,300.

TRANSFORMER LOCATION—Packaged substations with oil-filled transformers are available for outdoor service, with nonflammable units for indoor. Outside is the place for the transformer station if the highline voltage is over 10,000 and the reduction to 440 is made in one step. If the supply voltage is less than 10,000, the packaged indoor substation with nonflammable transformers is the general choice.

CONTROLS—Starters grouped in factory-assembled control cabinets are now standard for preparation plants. One central cabinet is satisfactory for a small plant, but a large plant may require cabinets at several locations to keep the motors reasonably close to the starters. Draw-type starters which can be pulled out for quick replacement are coming more and more into favor.

Dust is one of the major problems in location and operation of starting equipment. The best solution seems to be one or as few control rooms as possible made fairly airtight and fitted with blowers to maintain a slight positive pressure inside the rooms. Air forced into the rooms should be filtered.

CAPACITORS—The induction-motor load of the preparation plant produces a low power factor, which adds to the bill and heats conductors and motors. Capacitors should be installed in the plant to bring the lagging power factor up to unity. Theoretically, an appropriate capacitor should be placed at each motor. However, practical limitations of cost, space and maintenance generally make it advisable to group the capacitors in the control room.

Maintenance

MAINTENANCE is necessary because of wear and corrosion inevitable in operation, and the effects of the elements, for example:

1. **Rusting** of the exterior and interior, including structural members and equipment, as a result of rain, snow and water.

2. **Corrosion** from acid water and, on occasion, from the gases given off by burning refuse dumps.

3. **The effects of heat and gases** involved in heat drying.

4. **Wear** from the handling of coal and rock.

5. **Lack of lubrication,** overloading and other abuse, faulty electrical service and the like.

Maintenance Factors

All wear and corrosion cannot, of course, be eliminated. Use of the proper materials and proper designs when a plant is built, or when parts or sections are added or replaced in existing plants, are major factors in maintenance cost. These materials and designs include the following:

1. **Location of heavy equipment,** particularly of the rotating or reciprocating type, on or as near ground level as possible, cuts structural cost and reduces the effects of weight, motion and vibration.

2. **Bracing, steel weight, balancing and damping** to provide stiffness, reduce or eliminate unbalanced forces, and prevent the transmission of motion and vibration to the structure.

3. **Use of protected steel** and special roofing and siding materials, including asbestos-cement, aluminum and stainless steel.

4. **Protective coatings and paints** for steel exposed to rain, moisture, gases and the like.

5. **Neutralization of acid water** with lime or soda ash. Automatic feeding equipment now available facilitates this job. Frequently, neutralization will make it possible to get much-longer life from ordinary steel, saving both in material cost and replacement labor.

6. **Use of corrosion- and abrasion-resisting materials** for screens, chutes, flumes, water lines, pumps and so on, including plastic, rubber and asbestos-cement water lines and connections, and rubber-pinch and orifice-type valves. Stainless steel for bolts, for example, can solve some annoying corrosion problems in certain preparation applications.

7. **Use of linings to resist wear** and, with some types, corrosion. Examples include glass, tile and brick in chutes; and rubber, plastic, sand-cement and ceramic linings for tanks and cones. Another form of lining is special hard metal for conveyor bottoms. Hard-surfacing of wear points or the use of special wearing strips are natural steps.

8. **Use of totally enclosed, splashproof and other special motors** for dusty, wet and similar locations, plus moisture- and dustproof controls or the location of controls in rooms with blowers using filtered air and maintaining a slight positive pressure inside the rooms at all times.

9. **Good lubrication** with proper equipment and quality lubricants of the correct types applied at the correct intervals. Centralized automatic systems are growing in favor.

10. **Regular inspection and cleaning** of preparation equipment. Cleanliness and good housekeeping for the plant as a whole naturally supplement these, and to facilitate housekeeping a growing number of plants are being equipped with hoods and covers for certain equipment connected to exhausting and dust-collecting equipment, plus vacuum systems for cleanup.

Quality Control

CHECKING and control measures are both visual and mechanical or chemical. With lump, for example, the bulk and weight of a proper sample, and the increased difficulty of getting a representative sample, make mechanical and chemical tests difficult, and reliance must be placed largely on visual inspection. In washing, visual inspection — by operators who know their business — of the feed and draw material can reveal changes in condition immediately and permit adjustments to be made promptly, although this type of checking is subject to the normal human frailties.

Even with mechanical and chemical methods, the change in conditions takes place before the results are available, thus re-emphasizing the importance of adjusting operating conditions to provide the desired results as nearly automatically as possible. However, even though the data are obtained after the fact, mechanical and chemical tests are necessary to provide positive evidence of whether or not the desired results are being attained and permit adjustment if not.

SAMPLING—Where the tonnage is at all large and a careful check on quality is essential, one or more specialists should be charged with the responsibility of collecting samples. Depending upon the control setup, they also may run sink-and-float tests and prepare samples for more-elaborate chemical tests of the coal.

Number of samples and sampling intervals depend upon control and quality data required. Egg and lump—and perhaps nut and pea—may be sampled at longer intervals and perhaps only once a shift or longer. The problem grows more critical with the smaller sizes, especially where sales are made on a specification basis. As a result, many plants sample stoker and screenings, as examples, at intervals of as small as 15 min, while every hour is fairly common practice.

Automatic samplers installed at transfer points, especially for the smaller sizes, reduce the labor involved in sampling and tend to increase the accuracy. Manual methods include the car sample taken at a number of spots, but the trend today is toward cutting samples out of the coal as it flows into the car. A convenient method is to mount a narrow box of the requisite length and depth on a pivoted arm which is swung through the coal stream.

If the sample is intended for chemical analysis in the laboratory, time and labor can be saved by placing the preliminary sample-preparation equipment-crusher, splitter and the like—at or near the point the sample or samples are taken. As an example, some plants have provided platforms alongside the loading booms for sample preparation.

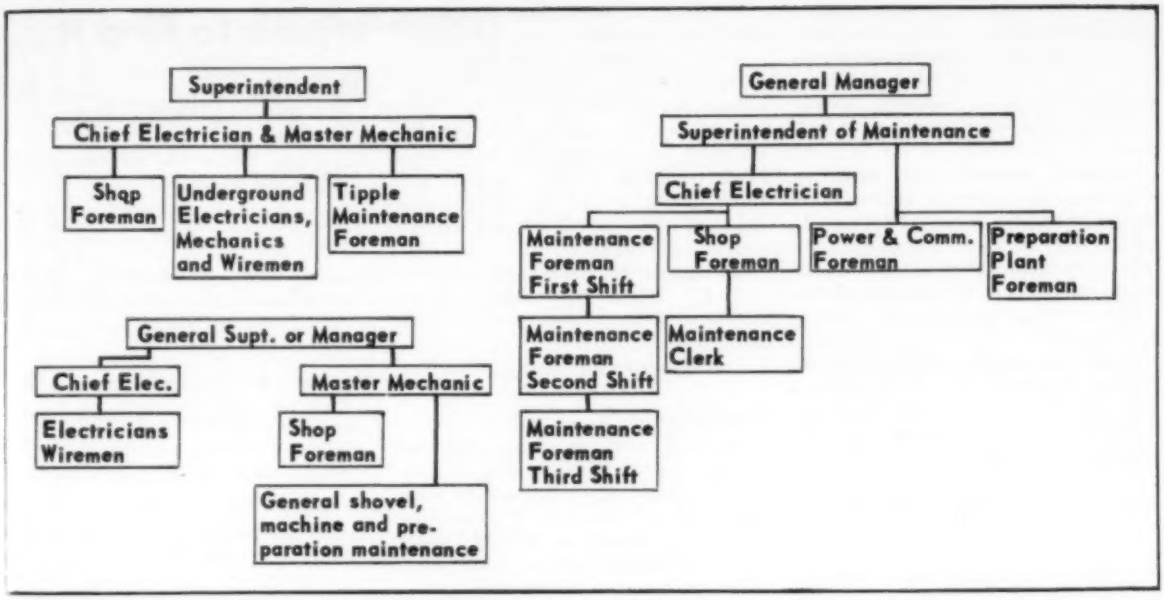
TEST PROCEDURE — Samples for checking cleaner operation normally are processed by sink-and-float. The equipment may be on the cleaning floor or at some other convenient location in the plant. The weight of the sink in a standard sample of cleaned coal is a working indication of how the cleaner is performing. The results also may be converted into fairly accurate ash figures by reference to a curve based on the average results of analysis of a representative number of samples.

Checking the efficiency of washer operation also requires testing of refuse.

More precise results of course can normally be expected by laboratory procedure, although the time interval necessarily is longer. Equally or more important, the laboratory is the only means of attaining all the chemical and physical data on both processing results and the character of the shipped coal, including ash, sulphur, moisture, heat content, fusion and softening temperatures of ash, and so on. Also, the presence of laboratory facilities permits research into suggested changes in preparation procedures and forecasting of results. Therefore, more and more plants are being supplemented by well-equipped laboratories (*Coal Age*, July 1959, p 80, as an example).

SIZING CONTROL—Since the accuracy of screening can have a major effect not only on realization but also on customer acceptance, quality control must take in size checking also. Facilities will vary with the circumstances at the individual plants but they should at least include a test-screen unit.

RECORDS—The type of records kept for operating and quality-control purposes should provide for putting down the data obtained in a form that will make it easily available to and usable by operators, supervisors and other interested persons. Graphic presentation by curves may be a part of the record system, and the data to be entered may include such things as valve settings on washers. For shipments, the record may show car number, size, ash, sulphur, heat content, moisture and so on.



SHARED RESPONSIBILITY between operating and maintenance departments facilitates efficient maintenance. Organizations are designed to meet the specific needs of individual companies, as shown in the three charts above.

Prescription Maintenance For Production Stability

Initial Target

Prevent or at least minimize production breakdowns by proper maintenance organization, including a preventive-maintenance program and "maintenance engineering" practices.

Key Objectives

1. Establish sufficient maintenance services and facilities to aid in keeping production costs down.
2. Improve maintenance methods and allocation of men and materials to reduce the cost of maintenance services and facilities.
3. Set up maintenance-management practices to keep costs within established budgets.

Key Approaches

1. Plan and supervise methods of equipment inspection, preventive maintenance, emergency and running repairs, equipment replacement, and scheduling and overhauling of equipment.
2. Provide and distribute AC and DC power, communications, compressed air, water and other required utilities.
3. Conduct maintenance-training programs and provide consulting service for management, production supervisors and maintenance personnel.
4. Establish and maintain a system for reporting and recording information regarding equipment, production delays and maintenance costs.
5. Improve equipment design to increase efficiency and safety.

Organization

ORGANIZATION is the establishment of authority, responsibility and relationships to achieve the end results. The necessity for applying and emphasizing these factors with regard to maintenance organizations has become more and more apparent with modern-day mining equipment.

Development

A maintenance organization and its program may seem complex when viewed as a whole but when reduced to its component parts it becomes simple and easy to understand. But why is maintenance so necessary? Here are a few reasons:

1. The influence of maintenance on production costs.
2. Effect of output with regard to operating versus breakdown time.
3. Protection and improvement of capital investments.

The establishment of an organization and the development of maintenance methods must have the support and understanding of top management if it is to be successful. To obtain this it is necessary to prove the value. Whether support is needed to set up a new organization or improve the services and

facilities of an existing program, it is important to present your case or proposal to management showing improvements and justification for the action. The proposal should include, among other things the following:

1. Cost of maintenance in relation to production. This can be shown as a percentage of total cost or in dollars and cents.

2. Analysis of operating time losses due to lack of maintenance and a rundown of where improvements can be made.

3. Data on maintenance productivity in terms of maintenance cost relative to replacement value of repair parts or equipment, or other comparisons which illustrate the point.

Impress upon management that you know your problems and offer the necessary plans, including cost estimates, methods of approach, time tables for expected improvements, etc., for those areas of maintenance to be included in the proposal.

Getting the go-ahead from management to carry out the proposal makes it necessary to take steps to measure, control and improve maintenance methods, facilitate proper allocation of men and material and reduce the cost of maintenance services and facilities. These tools include, among others, the following:

1. Classified Accounts—Simplify paper work and aid in monitoring all areas of maintenance cost and delays.

2. Delay and Work-Needed Reports—Keep management (operating and maintenance) informed of the effectiveness of maintenance and of immediate and future maintenance requirements.

3. Perpetual Equipment Records—Provide data for spotting weak machine components, indicate areas of high maintenance costs and enable maintenance management to determine when machines should be overhauled and when machine components should be changed or redesigned to improve performance and safety.

4. Program Plan and Work Schedule—Enables management to develop an orderly program for scheduling all maintenance work and assigning men so that it can be performed at designated intervals and completed within established time limits.

5. Maintenance Standards—Give management the necessary tools to evaluate work performance, job costs and methods of work procedure.

During development of the maintenance organization specific requirements in the administration of the program should be given priority. These consist of:

1. An organization capable of performing all maintenance functions effectively.
2. An organization chart listing the responsibilities and authority of each maintenance supervisor.
3. A neutral reporting medium for operating and maintenance department heads, including a rigid chain-of-command policy within the maintenance department and between it and the operating department.
4. A preventive maintenance program.
5. An effective cost-control program.
6. A complete report and record system.
7. A good supply system.

Responsibility

There is no single set of rules that can be applied in organizing maintenance systems. However, certain basic principles are necessary. Systems must be custom-designed to meet the needs of the individual company. As a result each maintenance organization reflects company policy, types of equipment, size of company, whether the company is engaged in deep or strip mining or both, and the general concept and basic philosophy of management. A good maintenance organization also will display the best in management practices, engineering judgment and common sense, plus proper distribution of responsibilities and authority.

Responsibility and authority, in a sense, are one and the same. Certainly a person or department should not be burdened with responsibility without having the authority to follow through. Whether or not any one function of a maintenance department is more important than another is secondary. What is important is that each function for which the maintenance department is responsible should be carried out in a businesslike manner and the cost kept within the budget, regardless of its priority.

The functions for which the maintenance department will be responsible should be established in the initial planning and organizing stage or, in existing organizations, the functions should be re-evaluated periodically.

The "major functions" listed at the beginning of this article provide a basis for developing a maintenance organization. The list can be altered to meet the needs of the individual companies.

Authority

Once the responsibilities have been established, delegating authority logically follows as the next step in organizing. Authority, which goes hand-in-hand with responsibility, should be based on analysis of the job to be done. It also should be defined and contain little or no overlap if confusion and buckpassing are to be avoided.

Where to Find It . .

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Personnel ..... p 317
Selection . . . Training

Procedure ..... p 317
Policy . . . Practice

Planning and Scheduling ..... p 318
Standards . . . On-the-job maintenance . . . Overhaul scheduling . . . Contract maintenance

Reports and Records ..... p 319
Production and delay reports . . . Equipment checklists . . . Work-needed reports . . . Inspection reports . . . Weekly and monthly delay summaries . . . Cost records . . . Filing

Spare Equipment ..... p 321
Limitations . . . Standardization . . . Unit changeout

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The desirable chain-of-command policy today is to provide a common or neutral reporting medium for production and maintenance department heads. The general manager or an executive of equal status, for example, has proved the more appropriate.

In the upper echelon of the organization the maintenance superintendent, assistant maintenance superintendent, chief electrician, equipment inspector and special engineers or supervisors have their specific place in the organizational setup, each position with its necessary degree of authority.

It also is necessary to establish lines of authority between first-, second- and third-shift maintenance foremen. There are two avenues of approach: (1) give the first-shift foreman control over the second- and third-shift, or (2) delegate equal authority to each shift foreman, thus placing them on the same level in the organization.

Title assignment is one area of maintenance structure where management needs applied common sense. Each supervisor should be given an appropriate title—one that matches his responsibilities

Field Reports

New Hydraulic Fluids—Equipment using hydraulic fluids, estimated annual consumption, possible synthetic fluids to reduce fire hazards. *Coal Age*, January, 1957, p 82.

Improvement Through Training—Program for mechanics and electricians involves 3-hr classes twice a week for minimum of 48 hr of instruction, plus practical exercises in electrical theory and troubleshooting. *Coal Age*, April, 1957, p 76.

Dual-Purpose Motor Tester—Unit capable of testing repaired or rebuilt motors under actual load conditions. *Coal Age*, October, 1957, p 92.

Testing Device Handles Three Maintenance Jobs—Unit presets 12BU Joy loader gathering head liquid clutches, load tests 9J motors and tests head and traction speed reducers. *Coal Age*, October, 1957, p 108.

Stainless Steel Sheathing Covers Plant—Stainless steel cover for plant exterior reduces maintenance and is resistant to corrosion. *Coal Age*, October, 1957, p 108.

Inspection Guide for Deep-Mine Equipment—Complete guide on what to look for and how to go about inspecting deep mine equipment. *Coal Age*, October, 1957, p 84; November, 1957, p 64; December, 1957, p 66.

Training: Foundation of Better Maintenance—An 18-mo training program for young men provides a reservoir of potential maintenance men. *Coal Age*, January, 1958, p 110.

The Beltman's Guide—How to install, repair, inspect and maintain belts. *Coal Age*, March, 1958, p 122.

Training for More and Better Maintenance Men—Joint efforts of coal operators' association and county vocational school solve the area's shortage of maintenance men. *Coal Age*, December, 1958, p 90.

nd authority and one that "flavors" his position with respect and prestige.

Personnel

THERE IS NO PLACE in a maintenance organization for men who are not electrically and mechanically inclined, who do not have the interest of the company at heart and who do not have the ability to serve as maintenance foremen or the potentiality to become such. If a maintenance organization is free of men who do not measure up to these standards it will be successful.

Selection

The best assurance a company can have against hiring unqualified supervisors or workers is to establish a system of personnel selection aimed at obtaining and qualifying good men. It does not have to be elaborate and expensive. Even in its simplest form it can serve to determine whether a man is certified or, better yet, qualified to perform the duties that will be expected of him.

It is only good common sense to select men with the ability to do a job rather than to hire somebody just because you need another man. The risk in selecting supervisors, who actually control your profits, requires more than the catch-as-catch-can method. The day of selecting maintenance personnel on the basis of friendship, favoritism and nepotism has passed. Good selections mean lower turnover costs, better employee morale, better production and lower costs of training.

Training

A training program must be designed to meet the needs of the company. The goals of such programs should be to improve the ability and efficiency of the men by giving them down-to-earth courses that will apply to their daily work routine. Many programs have failed because they were designed to teach theory alone rather than actual needs plus small doses of theory. However, it is important to expose men to basic theory if they are to learn the how and why of things.

Before a training program can be set up it is necessary to consider some of the problems that are likely to be encountered.

1. Will the program be sponsored by the company alone or in conjunction with a vocational school?
2. Who will attend the program?
3. What are the training needs?
4. What methods and techniques will be used?
5. Where will the training take place?
6. How will the courses be scheduled?
7. How large a group will be permitted to attend the courses?
8. Who will teach the course?

While the course of study for electricians and mechanics is pretty well determined by the work they perform—electricity, hydraulics and mechanics—the supervisor's training program is quite different. The supervisor deals mostly with people, not necessarily things, and also with personalities, not always technical know-how. There are a number of courses that can improve maintenance supervision and also prepare supervisors for possible advancements. The courses should include, among other subjects, the following:

1. Organization training.
2. Employment policy and procedure.
3. Maintenance policy and procedure.
4. Contract interpretation.
5. Report writing.
6. Communication policy.
7. Public speaking.
8. Human relations.

Before a training program can be successful it must have the full support of the operating department as well as the maintenance group. Anything short of complete support will result in failure of the training program.

Procedure

POLICY is the governing principle, plan or course of action followed by the maintenance department to achieve a sound and effective program. Practice is that part of the program designed to carry out the policy. Both policy and practice, however, are controlled, in part, by the operating department and should have the approval of the department heads before any procedure is adopted. At this point it is essential that both the operating and maintenance departments confer with the top echelon of management for final approval.

Policy

Essentially, the maintenance policy must include provisions for accomplishing all the responsibilities assigned the maintenance department.

All work activity of the department can be divided into five classifications:

1. Preventive maintenance.
2. Repair.
3. Overhaul.
4. Construction.
5. Salvage.

These five work-activity classifications can be further refined and broken down into three categories:

1. Predictable Work — Preventive maintainance.

2. Unpredictable Work—Emergency repairs and troubleshooting.

3. **Optional Work**—Overhaul, construction and salvage.

Once the maintenance program has been broken down into its simplest form, definite policies can be established to assure effective maintenance procedures. Preventive maintenance, for example, requires that equipment be inspected at regular intervals, that routine repairs be made frequently and that equipment be properly lubricated. These requirements, along with many others, are adopted by the maintenance department. Moreover, policy designates how, when and where the requirements will be fulfilled.

Practices

Essentially, the goal in maintenance practices is to see that plans, schedules and work forces are sufficient to carry out the policies of the department.

Of the three categories previously listed preventive maintenance offers the best means for achieving the greatest savings in maintenance costs. The paramount factors contributing to a successful preventive maintenance program are:

1. Selection of scheduled work.
2. Frequency of performing scheduled work.
3. Sufficient work force to complete scheduled work.

Emergency breakdowns or the unpredictable work cannot be controlled. Therefore, it is essential to provide sufficient troubleshooters to handle breakdowns, even if several breakdowns occur at the same time on one or more sections.

Overhaul, construction and salvage work can be contracted or performed by a work force maintained by the company. The problem is to determine whether or not it pays to contract the work or to maintain a working force to do it yourself.

Planning and Scheduling

WITH A WELL-ORGANIZED and sufficiently staffed maintenance force, prompt and effective maintenance can be accomplished. This also includes planning and scheduling of complete equipment overhauls, minor repairs and routine maintenance jobs, such as, inspecting and lubricating equipment at definite intervals.

Standards

Although industrial engineering has not yet been applied to maintenance in the mining industry to any degree, it does show promise of providing management with another tool to increase the effectiveness of maintenance and to reduce maintenance costs. Equipment and production techniques of today will influence the maintenance techniques of the future—and industrial engineering will play a major role.

Industrial engineering can serve maintenance organizations in a number of ways. These include, among others:

1. Simplification of work.
2. Improvement of shop layout and facilities.
3. Establishment of standard times for specific jobs.
4. Elimination of unnecessary job functions.
5. Increasing the effectiveness of planning and scheduling of all maintenance work.

On-the-Job Maintenance

The logical approach to on-the-job maintenance is to consider the necessary types of work to be performed. This leads to the "three-echelon" system, which breaks down as follows:

FIRST ECHELON—Inspection and minor running repairs at the face or in the pit make up first-echelon work. Normally, inspection is conducted by the section or pit electrician and mechanic, along with the operators, and the same men handle running repairs and adjustments.

First-echelon work also includes servicing the equipment, such as, lubrication, checking and inflation of tires (trucks at strip pits and rubber-tired equipment underground), cable maintenance and repair, and other similar operations.

Typical setups for manning face maintenance are one mechanic or electrician for one or two units, underground, and one or more men for each major class of equipment in the larger strips—for example, (1) shovels and draglines, (2) drills, pumps and compressors, and (3) trucks, tractors, graders, etc. However, organization is subject to considerable variation, and at smaller operations, or at operations with certain types of equipment of a rather simple and rugged nature, running maintenance may be handled by one man or one man and a helper.

Whatever the type of operation, however, the basic principle is assignment of sufficient specialists to a unit or a group of units to keep break-downs to a reasonable minimum, since overmanning, in maintenance as in other activities, runs up the cost in excess of the benefits in additional lost-time reduction. Economical maintenance requires proper manpower.

SECOND ECHELON—Major inspections involving some opening of cases and enclosures, and also major repairs or replacement jobs done during idle periods make up second-echelon maintenance. Part of this work, such as, inspection and replacement of certain units and assemblies, may be done at regular intervals, and part will be done when necessary to avoid a potential breakdown or take care of an actual one.

Such work normally falls to special groups, which may be: (1) permanent task forces or "bull gangs," (2) special groups of men normally employed in the underground or field shop—or perhaps the main shop, or (3) temporary groups made up by assembling the regular section or pit men on off-shifts or idle days. Similar task forces normally handle the maintenance of preparation plants.

THIRD ECHELON — Normally, third-echelon work involves complete overhaul of a machine on the basis of time, tonnage, yardage or hours worked. Underground units and small stripping units, as examples, normally are brought to the shop, or sent to an outside custom shop, for complete dismantling and rebuilding, and large stripping units are moved back from the face or out of the pit to prepared overhaul areas.

Aside from equipment, third-echelon work takes in such other activities as the repair of conveyor belts, large truck tires and similar items, for which some companies have special shops or shop sections. Others use custom shops or manufacturers' repair and service facilities.

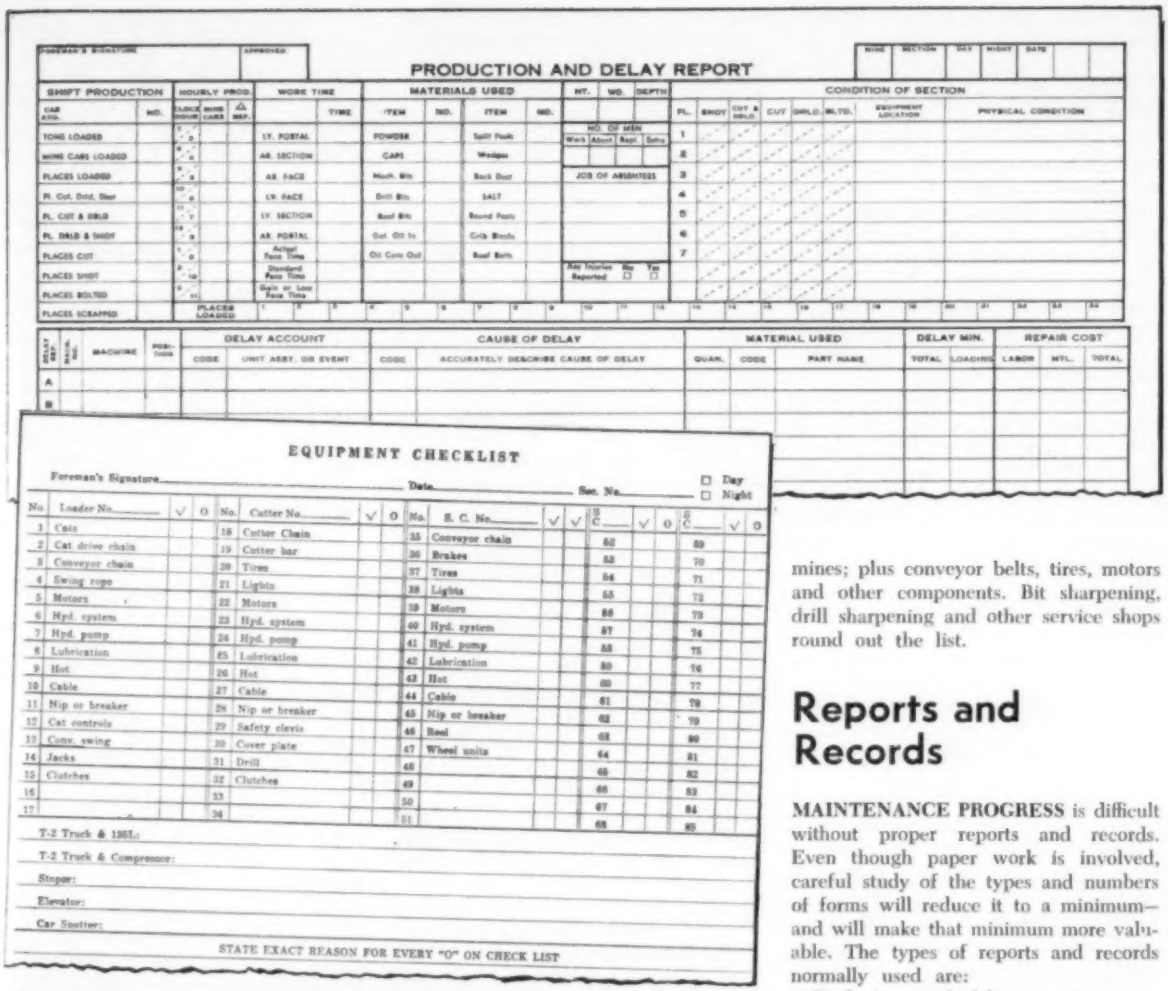
Since overhaul, in addition to skill in dismantling and assembly, requires, as a rule, basic skills in metal-working and the like, and normally also requires bringing the equipment to the main shop or a prepared overhaul area, maintenance men handling this class of work are largely kept on it alone, though certain men occasionally may be sent into the mine or pit to handle certain face or field jobs. The number of men and the specialties involved again depend upon the situation at the particular operation.

Overhaul Scheduling

Five of the standards for determining when overhauling is necessary are:

1. **Elapsed time**—in weeks or months. In other words, machines are taken out of service at specific intervals for overhaul.
2. **Operating time** in hours or days.
3. **Tonnage or yardage handled.**
4. **Inspection.**
5. **Personal judgment.**

Each of these standards has its supporters among maintenance and operating men, though more of them seem to operate on the basis of a combination of



PRODUCTION AND DELAY REPORT

EQUIPMENT CHECKLIST

PRODUCTION AND DELAY REPORTS, and equipment checklists, provide perpetual performance records for equipment. Reports above are filled out by section foremen.

inspection and hours operated or tonnage or yardage handled. Where the number of units is large, on the other hand, supporters of the elapsed-time standard point out that a rigid schedule is necessary to permit getting around to all the machines without jams resulting from two or three coming up for overhaul.

A sixth system is, in effect, no overhaul—or overhaul only at long intervals. Under this system, known as unit replacement, overhaul is accomplished by replacing assemblies, such as rear conveyors on loaders, crawlers on shovels and the like, removing the replaced assemblies to the shop for overhaul and storage until another assembly on another machine comes up for replacement.

What might be called a seventh system is practiced at at least one mine where the coal is low, belts are employed, and the difficulty of handling a major breakdown is much greater than in thicker coal. At this operation, each new panel is started with equipment that has been completely overhauled, the crew merely transferring from a worked-out panel and leaving the machines to the maintenance force.

Contract Maintenance

Since outside shops serving a region or a large part of the industry have an opportunity to install more facilities and employ more men with the necessary skills because of the larger volume of business, they are increasingly able to offer major-repair and overhaul advantages, especially to organizations not large enough to support full-scale facilities. Shops now in existence, along with facilities offered by equipment manufacturers, are set up to give speedy, efficient service in overhauling and repairing loaders, continuous miners, shuttle cars and other underground equipment, and bulldozers, small shovels, engines and similar equipment for strip mines; plus conveyor belts, tires, motors and other components. Bit sharpening, drill sharpening and other service shops round out the list.

Reports and Records

MAINTENANCE PROGRESS is difficult without proper reports and records. Even though paper work is involved, careful study of the types and numbers of forms will reduce it to a minimum—and will make that minimum more valuable. The types of reports and records normally used are:

Production and delay reports.
Equipment checklists.
Work-needed reports.
Inspection reports.
Weekly and monthly delay summaries

Cost Records

In addition to the major reports and records noted, there are others which pinpoint and simplify maintenance practices. These include overhaul-estimate reports, motor-brush inspection forms, substation checklists, locomotive-delay records and maintenance request forms, detailed equipment-data sheets, loading-machine conveyor-chain-performance records, cutting-machine cutter-chain-performance reords, shop-repair requisitions and receiving reports, and monthly reports on scheduled v. emergency repairs, including reasons for emergency changes.

To simplify the various forms and to reduce writing a delay-account code for mine and preparation equipment should be established. The mine code should provide numbers for all delay sources. The preparation-plant code should provide numbers for each equipment item

in the plant and also numbers for non-mechanical delays.

Production and Delay Reports

The daily delay or operating report is a must. It shows what the mechanical and electrical failures were and how much time was lost with each. Also, these reports may be expanded to show other delays and their causes to permit appropriate action. Thus, they become running time studies of machine performance, and provide invaluable data for eliminating the causes of reduced efficiency.

This report may be rather simple and concentrate on production and delays only. Or, it may include details on labor, parts used and a description of work done. For example, a delay report may provide space for recording such information as:

Machine Data—Number, type and position.

Delay Account—Code, unit-assembly or event.

Cause of Delay—Code, reason for delay.

Material Used—Quantity, code and part number.

Delay Time—Total downtime and loading time lost.

Repair Cost—Labor and material.

Equipment Checklist

This form, filled out by section and plant foremen, lists the code numbers and equipment items. Space is provided at the right or left of each equipment item to indicate whether it is in good condition or whether it needs attention. Space also is provided to permit foremen to explain why equipment needs repair.

Work-Needed Report

To attain fully the goal of preventing breakdowns, some form of reporting on work or adjustments needed is a necessity. It permits reporting a part that seems likely to fail so that the necessary steps may be taken to repair or replace it on the next idle shift.

Work needed may be reported either on the front or back of the regular delay form, or it may be reported on a special form. Where it is entered on the regular form, special handling may be necessary to make sure that both the repair foreman and the superintendent, for example, get the data they need without delay. Or, the forms may be made out in duplicate or triplicate and routed accordingly.

Where separate forms are used, the original naturally goes to the repair foreman, with perhaps a copy to the superintendent. In some instances, the form includes space for reporting on when the work needed was done, with or without copy to the superintendent, as a further means of insuring that prompt action is taken.

Inspection Report

As a second means of preventing breakdowns, a number of mining operations have instituted inspection reports. The frequency of such reports can vary from daily to monthly or longer, with a week or a month the most common. The reports are derived from special inspections of a varying degree of thoroughness, and normally involve going into certain cases and the like. In other words, the machine is given a more thorough examination than would normally be involved in a quick daily once-over.

Inspections may be made by the regular section electricians or mechanics, or by special men from the mine or central shop. These men at the same time can make certain adjustments and repairs, and can note larger jobs that may require taking the unit out of service.

A recent newcomer to mine maintenance personnel is the electrical-mechanical inspector. His primary duties are to conduct and plan inspection schedules for all equipment, make out equipment reports and submit them to responsible operating and maintenance heads, to make sure that work orders are carried out and completed as scheduled, and to recommend when certain equipment should be taken out of service for overhaul.

Weekly and Monthly Delay Summaries

These reports provide a periodic summary of the progress and effectiveness of the preventive-maintenance program. Weekly reports give a quick breakdown of the amount of delays by section (day and night shifts) and the frequency for each delay source. Total delays in minutes, percentage of work time lost and the amount of tonnage lost complete the standard weekly summary report.

The monthly delay summary is a more comprehensive report than the weekly. It gives a broader view of the over-all program and enables supervisors to spot weak or trouble areas in the maintenance structure. Information contained in the monthly summary is obtained from the weekly reports.

Cost Records

There is a growing trend toward keeping a complete record of repair parts and labor unit by unit. Labor in this instance normally means special labor beyond the usual attention given by the section mechanic—in other words, shop and special labor required for major repairs and overhauls. Paper work is increased but the accurate unit record provides, among others, these advantages.

1. Excessive expenditures may signal waste or loss of parts sent into the section for running repairs, as well as lack of lubrication, abuse of the machine by operators, and so on.

2. Rising expenditures may signal the need for overhaul earlier than normally scheduled to prevent excessive machine breakdowns.

3. Consistently higher expenditures for one type of machine, compared to another of equal capacity, may make it desirable to standardize on the lower-maintenance unit, other things being equal.

4. Data on the value of special materials—for example, stainless steel—can be readily obtained to show if they are worthwhile or not.

For maximum convenience, unit cost records may be kept on cards designed for rotary or other quick-viewing files. The data for the records naturally comes from requisitions for parts and materials submitted by the foremen or other responsible officials, and from reports on parts used and labor expended by the repair foreman. Naturally, also, summaries of the unit records should be made at regular intervals—perhaps monthly—for the superintendent and other officials having jurisdiction.

Filing

The type of report will, in many instances, indicate who should file it—for example, a report on work completed by the repair foreman, or on lubrication by the head of the lubricating crew, if one is employed. Daily delay and operating reports may be filed by the foreman or the operator of the key machine, with some arguing for the machine operator since the foreman may not be with the machine at all times. Operator reports, if that is the system, naturally should be filed through the foreman, who will check and countersign.

Where several machines make up a unit, there may be a question as to whether reports should be required of the several operators—for example, cutters, shuttle-car drivers, etc. Among other things, such reports might be valuable by focusing operator attention on the need for good maintenance and care in operation. Practically, however, one report, especially if prepared by or with the cooperation of the foreman, usually can provide the necessary information.

Reports on work needed likewise may be filed by the operator, the foreman or the section mechanic, working with each other.

Whatever the number and scope of the various reports, the rule should be a practical system.

Spare Equipment

ONE METHOD OF ALLEVIATING the effects of major breakdowns is keeping spare units on hand, provided the cost of such spare units can be kept within reasonable limits.

Limitations

On large units it is impracticable to buy, say, two 30-yd shovels, one to substitute for the other when it breaks down. The goal here must necessarily be one of making sure that breakdowns are kept to the absolute minimum, and that the shovel is maintained in such condition that major overhauls are required only at rather long intervals.

With smaller units, such as underground loading machines, a much greater opportunity exists for keeping spares on hand without excessive investment. General practice is to provide a spare for each 3 to 5 major production units, such as, loaders, cutters, continuous miners, shuttle cars, etc.

Basically, the number of spares depends upon conditions and particularly on the extent to which preventive maintenance reduces major breakdowns. Time necessarily is involved in getting the inoperative machine out of the way and the new one in, regardless of how close the spare may be. If breakdown time can be kept below that figure without exception, there theoretically would be no need for spare units, except to maintain output during overhaul periods.

But since breakdowns have an annoying habit of causing lengthy delays, there is an opportunity for the spare units, and that opportunity increases as breakdown frequency and time increases. However, there is a drawback. Investment in equipment—and in parts and labor to take care of breakdowns—also increases. The conclusion is that preventive maintenance on the working units is the real goal, and will reduce the need for spare equipment and also the breakdown cost.

A second factor determining spare-unit practice is the overhaul schedule. With intervals of 6 mo to 2 yr on major underground units and on certain surface units, and with overhauls requiring up to a month or more, spares are a necessity if production is to be maintained at a certain level. Usual practice is to take an underground machine out of the section, or a small portable unit out of the strip pit, and send in the spare unit. Certain underground mines, however, follow the practice of keeping extra completely equipped sections, and transferring the crews for the overhaul period, on the basis that moving men is less costly than moving equipment.

Standardization

Standardization of mining equipment, of course, has its limits, and complete standardization would make it difficult to work in new types of machines and thus take advantage of their characteristics. But with fewer types of equipment, including components such as motors and the like, there is a much greater opportunity for learning all about the equipment and how to handle it. Also, repair-part inventories are reduced and the problem of receiving, storing and issuing parts is simplified.

Unit Changeout

The most recent advance in mine maintenance is the unit changeout system. Although this system involves a rather large initial outlay of capital the results after the program gets under way show a substantial decrease in machine downtime and replacement of parts.

The success of this program depends on five major factors:

1. **Organizing the program.**
2. **Evaluating the equipment** to determine within safe limits the average life of the various units that are to be changed out periodically.
3. **Supplying an adequate number of spare units** and replacement parts.
4. **Allocating a sufficient number of men** to carry out the program, both in the shop for rebuilding the units and inside the mine for changing chem out.
5. **Keeping an accurate record** of each equipment item.

Once the program is in operation, accurate records must be kept to insure its success. Records, for the most part, consist of a master equipment chart. This chart lists all equipment and its location, and provides space for recording information on the units of each machine that are included in the changeout program. The information includes frequency of changeout, when they were changed last and when they are to be changed out again.

Shops

DESIGN SHOPS to take into account individual conditions, such as, size of operation, type of equipment, type of work done and other factors.

Central Shops

Central shops generally are defined as establishments where work beyond the removal and replacement of parts and assemblies is done. It is difficult, however, to be precise as to what main or central shops are, since they vary widely in goals, scope of work handled, and equipment. Normally, however, their main business is major repair and overhaul, and to facilitate this they usually include machine tools and other equipment not found in mine shops. On the other hand, main shops can function as mine shops, and they may also, in some instances, include facilities for manufacturing repair parts and even complete equipment units, such as, for example, pumps and shaker pans.

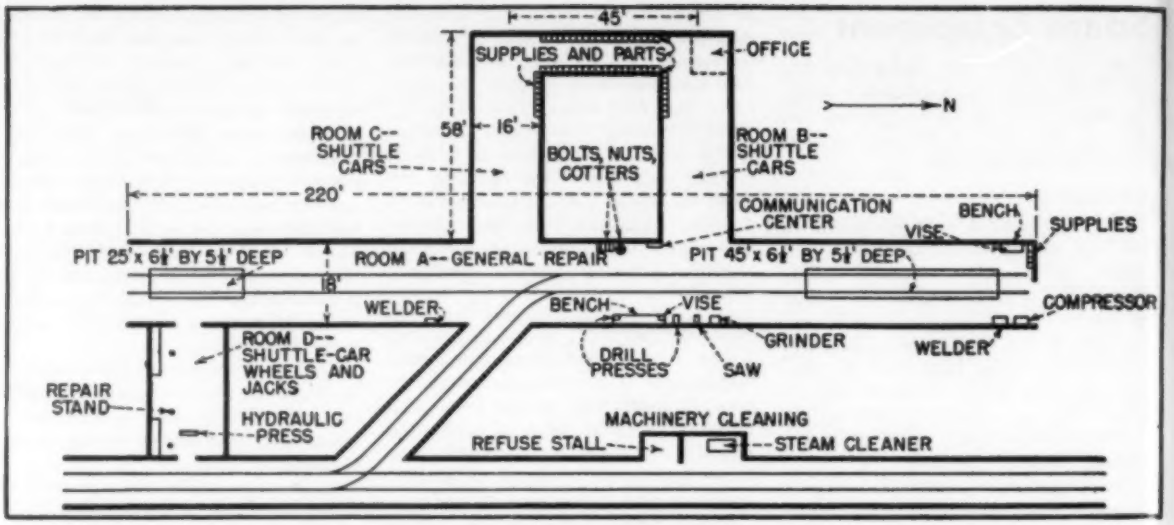
Where several mines are operated by a single company, the question arises as to whether to have a main shop at each operation or a big central shop for all. The trend seems to be toward centralizing main-shop work in one plant, especially where good highway and rail connections are available. The advantages include:

1. Less duplication of equipment and facilities, in turn providing an opportunity for adding extra facilities in the main shop without increasing overall expenditure.
2. An opportunity to provide additional repair and maintenance skills because the volume of work is sufficient to warrant employment of certain specialists.
3. An opportunity for increasing efficiency because of the greater volume of work in one place.
4. Less duplication of parts and supply inventories, and consequently a reduction in inventory, as a result of concentration of operations.

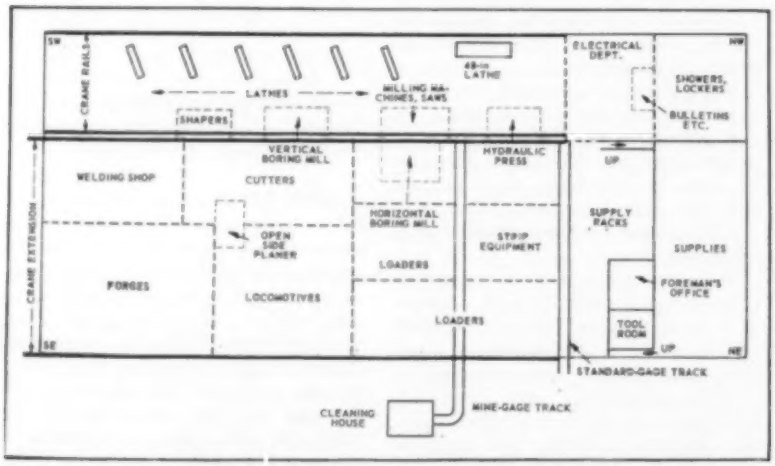
SHOP TYPES—Main shops may include types aside from the general overhaul and repair units devoted to machine reconditioning. Examples are: conveyor-belt shops, wheel-reclamation and welding shops, truck-tire shops, mine car shops and so on. Such shops may be separate or may be incorporated into the main shop via separate rooms, bays and the like, and, of course, are warranted only when the volume of specialized work is sufficient to make them practical.

SHOP LAYOUT—Since size of operation, type of equipment, type of work done and other factors vary widely, no prescription can be given for a typical main or central shop. A summary of layout and facilities for three specific shops, however, is as follows:

STRIP-MINE SERVICE CENTER—L-shaped shop, warehouse and garage structure, with 66x215-ft garage as the base of the L; next, a 59x32-ft warehouse; and completing the upright of the L, a 59x84-ft machine shop. Thus, the warehouse is conveniently located between the machine shop and the garage. The garage is fitted with 10 rollup doors, and handles the maintenance and repair of all gasoline, butane and diesel equipment and pumps (but not motors), as well as serving as the headquarters for the maintenance of two small walking draglines. Extra en-



MODERN MINE SHOP includes machine-cleaning section and special rooms for certain equipment and parts.



MAIN SHOP provides facilities for overhauling equipment, including special machine work, steam cleaning, welding, forging and electrical work.

gines, and some heavy spare parts, including some rear end transmissions, are kept in a fenced-off enclosure in the garage, which is equipped with a 2-ton hoist on an overhead track.

The warehouse includes a 25x25-ft partitioned section in one corner serving as the electrical shop. Warehouse facilities include convenient outdoor storage for heavy shovel parts while lighter parts that can be brought inside—via a 5-ton chain hoist mounted on overhead rails—are stored on the floor. Bins, of course, are provided for the smaller items.

The machine shop does work for the garage, electrical shop and the field force, and is equipped with three radial drills—one large and two small; horizontal lathe, 20-ft bed, 36-in swing; 12-in lathe, 18-in utility saw, shaper, bolt machine (up to ¾ in), three hand-welding machines, automatically controlled gas-cutting unit, automatic continuous welding machine, two 5-ton and two 2-ton chain hoists. Work done includes building dipper sticks 63 ft long.

DEEP-MINE CENTRAL SHOP—Three-building establishment, all connected with doors wide enough and high enough to permit passage of portable cranes, thus avoiding the use of heavy overhead cranes and hoists; windowless Quonset construction, with fluorescent lighting. Unit functions equipment are:

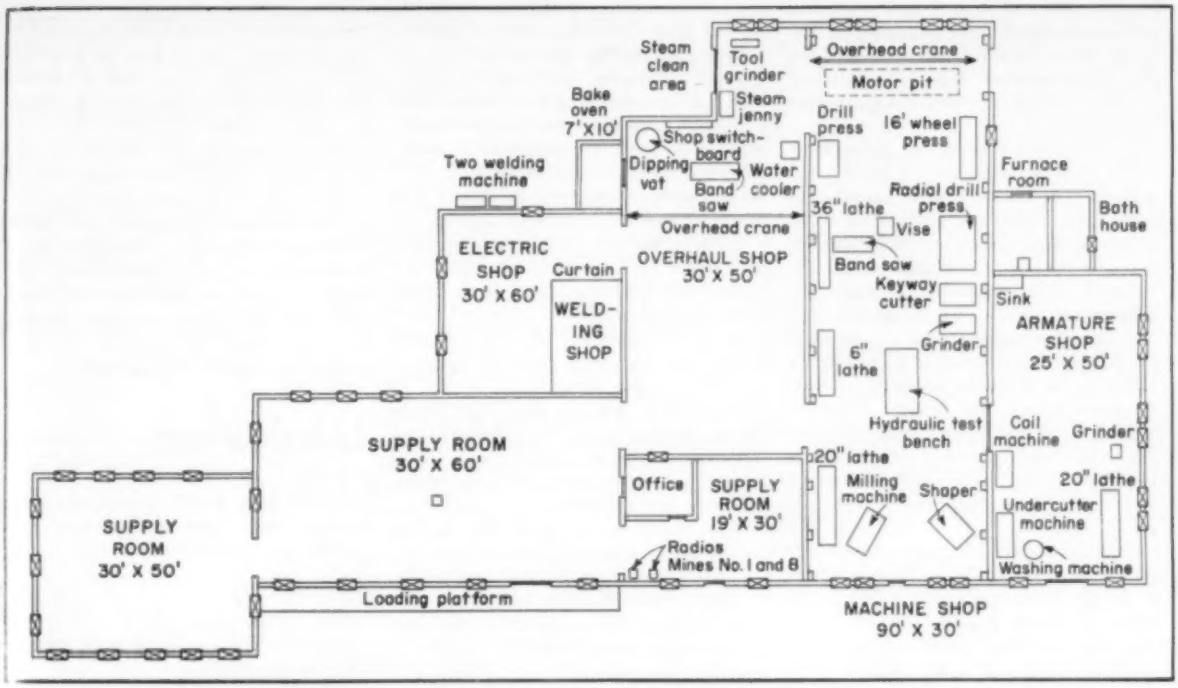
Building 1, 40x100 ft, rebuilding shuttle cars, loaders and continuous miners; steel work benches, two bench drills, vises, two 300-amp portable welders, gas-welding equipment, air-operated impact wrenches and portable drills, test panel for mercury tubes.

Building 2, 40x100 ft, rebuilding rubber-tired cutters, rubber-tired coal drills, roof drills and other mining machinery; wall-type work benches, special floor-type work bench for repairing shuttle-car wheel units, two welding machines, cable vulcanizer, cable-conductor welder, and 150-kw rotary converter for DC test power.

Building 3, double Quonset 60x80 ft plus single Quonset 60x40 ft, building up and machining parts for mines and preparation plants; wheel press; 20-in, 48-in and two 24-in lathes, milling machine, radial drill, 20-in shaper, bolt threader, slotter, metal-cutting band saw, bit cutoff machine, blacksmith forge, air compressor for the three buildings, two degreasers, heating boiler, welding machine, and floor controlled bridge crane across lathe bay; also toilet and shower facilities in 20x20-ft room.

DEEP AND STRIP SHOP—Though designed primarily for the complete rebuilding of underground equipment, one shop also handles certain work for the company's strip operations. Size of the two-story building is 213x95 ft inside, and it includes offices and a supply room. A modified assembly-line procedure is followed, with types of machines assigned to certain bays, and parts removed to service bays for reconditioning before return to the unit. An outside cleaning station is a major contribution to quality and efficiency.

While, as noted, shops vary widely in character and facilities, certain practices and equipment lead to higher quality of work at lower cost. These include: good light, convenient lockers and work benches, special benches and stands for certain work (shuttle-car wheels, for example), supply depots in the shops themselves or at least close at hand, hoisting equipment for lifting and mov-



CENTRAL SHOP AND SUPPLY HOUSE combination speeds overhaul work and reduces inventory.

ng anything heavy, including such hings as shafts into lathes, and power-perated tools—impact wrenches, etc. leaning and degreasing equipment ontributes greatly to comfort and effi-iency.

Other facilities included in the design f a main shop (see illustration) consist of a foreman's office, supply room, howers and lockers for personnel and a separate section for the electrical department.

While design and shop facilities influence quality of work and efficiency, the need for qualified supervisors and skilled workers also must be considered. A good shop must not only be well equipped but must have men that can do the work.

Mine Shops

Although a few deep mines make a practice of maintaining machines up to the stage of semi-overhaul in the working section, lack of space, the difficulty of doing welding, light and coal dust, among other things, normally dictate the transfer of major repairs, replacement of assemblies and semi-overhaul to shops maintained for that purpose. Some of these conditions do not prevail in strip pits, and consequently there is a greater opportunity for doing second-echelon work away from the shop. And with large stripping units, the only practical way to work on them is in the field in special repair areas, though some components and assemblies are processed in the shop or shops. In preparation, also, the nature of the plant and equipment also dictates doing a major part of the work on the job, though parts and assemblies may be removed for shop repair and return.

DEEP-MINE SHOP LOCATION—Distance and whether or not the equipment must be hoisted up slopes or shafts are among the factors involved in location of deep-mine shops. A third is facilities for quick moving of units from the face to the shop and back, such as, special transporters. Where good transportation facilities exist, and hoisting is not involved, it may be possible to locate mine shops on the surface and thereby get the advantage of space, natural light and the like, including convenience, at a somewhat smaller expenditure. But where the distance is great, and where hoisting is involved, there are strong reasons for locating the shops underground. With proper planning and design, they can be made almost as convenient as surface shops—and as efficient—and have the major advantage of being closer to the actual working sections.

Moving the shop as the mining location shifts also is possible with certain types of mining—contour in particular, as well as auger. Some such operations use small prefabricated buildings mounted on skids or trucks as shops or supply houses or both, moving the unit or units as needed as the mine opening moves around the outcrop.

Certain types of maintenance work, such as cable repair, may be done in small specialty shops set up at substations or other points where attendants are necessary to take advantage of what otherwise would be idle time.

STRIP-MINE SHOP LOCATION—Central location and convenient access from highways, both on the property and off, are among the considerations involved in locating strip-mine shops. Frequently, these considerations result in the shop being located with the other mine facilities, such as, the mine office and the preparation plant, especially since big units are necessarily repaired in the field, and trucks, tractors and small units can be brought in under their own power or by the use of transporters, even when they are not required to come to the preparation plant regularly. An exception might be a truck garage and shop where the trucks haul to field stations or to rough cleaning plants moving coal to central plants by rail after rough cleaning.

Specialty shops employed by some stripping organizations include a portable welding shop, fabricated from corrugated steel, and mounted on wheels, and large enough to go over a truck or other unit. This facilitates body and other repairs where the unit cannot readily be brought into the shop without dismantling.

SHOP FACILITIES—Even the simplest deep-mine shop for major repairs, replacement of assemblies and the like should be equipped with a pit, hoisting

facilities and a parts store room, plus the necessary special tools required for the work done. Parts-cleaning equipment should be installed if possible to speed up this operation and facilitate subsequent work.

At the other end of the scale, mine shops may be large and elaborate and able to handle everything up to complete dismantling and reassembly of all types of machines. One shop of this type, located near the bottom of the hoisting shaft, includes high-intensity lighting, a general repair section with two pits plus overhead cranes and small hoists, two bays for shuttle-car service with hoisting facilities, an office, cabinets for parts, a room for repair and servicing of shuttle-car wheels and hydraulic-jack units with monorail crane, and a cleaning recess with permissible-type steam cleaner supplemented by a refuse stall.

Tools include saw, floor-type drill press, vises, bench drills, floor grinders, hydraulic press, welding machines, and portable electric and air grinders. Facilities also include 32 tool cabinets built into the walls, and a compressor.

IN-PLANT FACILITIES — Though not a part of shops, certain permanent facilities of a shop type serve very useful purposes in certain maintenance applications. Examples are compressed air and welding gas lines and outlets in preparation plants, and arc welders in preparation plants and strip shovels. Time saving is the major advantage.

Mobile Repair Units

The repairman's jeep, with space for carrying parts and supplies and lockers or compartments for tools, has become a fixture at many underground mines because of the speed with which it can deliver both men and materials to the scene of a breakdown. Similar units also speed up the work of wiremen, bratticemen and other service workers. Other mobile maintenance units include welding trucks—gas and electric—where there is an opportunity to use such equipment in fresh air.

DEEP MINES—Skid-mounted "maintenance centers" (*Coal Age*, September, 1955, p 78) are among the newer types of mobile repair units. Designed particularly for trackless mining and moved by hitching them to a shuttle car, the centers consist of 4 x 5 x 12-ft steel tanks with flat tops providing bench surfaces for work. Among other advantages, a supply of spare parts is always within 100 ft of the face.

For bringing machines to fresh-air locations, and for other purposes, including moves, crawler-mounted pullers or carriers have been found very useful at a number of mines, especially in low coal. And where machines must be moved long distances, such as loaders, miners and shuttle cars to main shops, lowbed transporters speed up the operation and save wear and tear on the units.

Where pullers are not available, several tricks may be employed to move disabled machines—for example, a drill motor with an adapter to power the crawlers on a loader for short moves.

STRIP MINES—Mobile maintenance equipment at one strip operation includes the following, aside from greasing and fuel trucks:

Small-tool truck for all types of small hand tools and parts normally required on maintenance jobs.

Large-tool trailer for transporting heavy tools required in major jobs on big stripping units.

Flat trailers for moving wood blocks, cribbing and the like.

Special heavy-duty trailer for hauling buckets and shovels up to 100 tons.

Small-parts truck.

Truck-mounted crane with boom sufficiently long to handle all lifting jobs necessary in maintaining 40- to 50-yard shovels.

Welding trucks.

The number and variety of units reflects the fact that this is a very large operation. At a smaller strip plant, this number and variety would not be practical, but a welding truck plus a general repair truck, or one truck for both purposes, represents possibly the minimum of mobile units.

COMMUNICATION—If for no other reason, a good communication system from the face or pit to the main office and repair shop normally will pay for itself through reduction in breakdown losses alone. In strip pits, two-way radio is one of the answers, and includes certain mobile units in the superintendent's car, the repair foreman's car or truck, and the cabs of the key stripping units, among others. A good telephone or trolley system yields the same results in deep mines.

On-the-Job Supplies

IF A REPAIR PART is not close at hand, what might be only a minor breakdown can turn into a major stoppage if the item, such as a chain link or hydraulic hose, is missing, requiring a special trip to the supply house or the main shop. Limiting down time therefore requires keeping an adequate stock of the smaller, frequently used items in the section or pit, where they are readily available for the mechanic or electrician. Where heavier, less frequently used parts or critical assemblies are involved, one or more can be kept at a central location, perhaps on a truck or carrier, but still handier to the working sections or pit than in the main shop.

To prevent loss or damage, section parts should be kept in a supply cabinet, a parts box, or in lockers, drawers, etc., in the foreman's or repairman's shanty or office. Some mines also have found it advisable to keep certain special tools with the parts so that they are handy when needed. Lamps or other heating facilities should be provided for parts subject to damage by moisture.

Lubrication

A GOOD LUBRICATION SYSTEM will contribute greatly to reducing maintenance costs (labor and material) and production breakdowns.

Responsibility

Attainment of an effective lubrication system requires acceptance of perhaps three responsibilities.

1. Selection of lubricants and lubrication equipment.
2. Establishment of a lubricating schedule.
3. Application of lubricants.

Lubricant Selection

Selection of lubricants normally falls on the maintenance department, though the importance of lubrication might well warrant the employment of a lubrication engineer—at least where a company operates several mines and a large number of producing units.

The recommendation of the equipment manufacturer is the starting point in lubricant selection, with the second major source of data the service departments of the oil companies. A third source of information, provided proper records are kept, are the lubricating and delay reports, which may indicate that a change in type is necessary. When all the preliminaries are completed, lubricants then should be bought on performance rather than on general representations, and the rule should be the highest possible quality in view of the penalties now suffered as a result of equipment breakdowns. The latter, for example, comes into consideration when gear oils, for example, are being specified. Use of the extreme-pressure type covers all applications with a quality product and eliminates the chance of misapplication in lubricating the operating units.

STANDARDIZATION — Too many types of oils or greases lead to confusion, misapplication, contamination and loss. Careful study of the lubricating problem

DAILY LUBRICATION

MINE:_____ SECTION NO._____ DATE:_____

LOADER SERIAL NO:_____, _____.

Lubrication Points:	Lubricated Yes	Lubricated No	Use Lubricant
1. Frictions RH & LH	☐	☐	Hydl. Oil
2. Gathering Head Gear Case RH & LH	☐	☐	Y
3. Cat Drive Speed Reducer RH & LH	☐	☐	Y
4. Crank Pin Bearing	☐	☐	Z
5. Gear Case Seal	☐	☐	Z
6. Idler Arm	☐	☐	Z
7. Cat Idler RH & LH	☐	☐	Z
8. Conv., Tail Roller	☐	☐	Z
9. Cat Drive Sprocket Bearing RH & LH	☐	☐	Z
10. Conveyor Hinge Pin Upper & Lower	☐	☐	Z
11. Rope Sheaves	☐	☐	Z
12. Conveyor Chain	☐	☐	Hydl. Oil
13. Cat Drive Chain	☐	☐	Hydl. Oil

DUTIES AND RESPONSIBILITIES OF GREASES

1. Properly lubricate all equipment assigned to him.
2. Help float out S/Car crewmen for lunch.
3. Each shift the greaser will clean out the S/Car reel cases and, keep the sheave wheels free of accumulation of obstructive material, also, clean the operators platform and any other accumulation of obstructive material as may be encountered on the wheels and chasis of the shuttle car.
4. Fill to capacity all hydraulic tanks on equipment assigned to him.
5. Grease daily all miscellaneous equipment that may be assigned to his section such as:

   Car Hoist — Conveyors, Head
   Elevators — and tail pieces.
   Piggybacks

6. After performing regular assigned duties, the greaser is at the disposal of the foreman in charge.

PERIODIC MAINTENANCE

	Date: Month	3	3			
	Date: Day	13	13			
Periodic Inspection	Operating Shifts:	1/2	3/4	5/6	7/8	9/10
Motors 20 Shifts	Loaders	6771				
	S/Buggies					
	T/Trucks					
	Machines					
	Piggybacks					
Clutches 40 Shifts	Loaders					6771
Clutches 40 Shifts	S/Buggies					
Cable Reel 40 Shifts	S/Buggies					
	T/Trucks					
Contractors & Switches As Scheduled	Loaders	6771				
	S/Buggies					
	T/Trucks					
	Machines					

Periodic Shuttle Car Lubrication

	Date: Month	3		
	Date: Day	13		
S/Car Serial No.	Operating Shifts:	1/2	3/4	5/6
3220	S/Cars Day			
	S/Cars Nite			
	Symbol			
	Date Greased			
3223	S/Cars Day			
	S/Cars Nite			
	Symbol			
	Date Greased			
	S/Cars Day			
	S/Cars Nite			
	Symbol			

INSPECTION REPORTS and lubrication charts insure repair and adjustments before breakdown.

will show, in many instances, that a lesser number of types of high quality will do the job, since the variety of lubricants available include many with the necessary spread in characteristics fitting them to several applications.

As an example of what standardization can accomplish, one large stripping organization, also operating a large and modern preparation plant, cut the number of lubricants from 29 to 9, as follows.

	Types Before	Types After
Motor oil, heavy-duty detergent	2	1
Gear oil, all enclosed gear cases	4	1
Antifriction-bearing grease		1
Plain-bearing grease	5	1
Open gears	3	2
Cable dressing	5	1
Compressor oil	3	1
Hydraulic oil	7	1
Totals	29	9

Scheduling

Scheduling, with attendant reports and records, is perhaps one of the most vital elements in efficient lubrication, and here again the responsibility rests on the maintenance department or the lubrication engineer.

An efficient lubrication program depends upon definite scheduling of the work, accompanied by definite instruction as to the type of lubricant to be used. This means a written document for the information and guidance of all who have anything to do with lubrication, and this document may also serve as a report on work done. Tags enclosed in plastic envelopes may, for example, be tied to tractors, with one side of the tag showing points to be lubricated, type of lubricant to be used, and when lubrication is to be done, and the other side serving as a record of lubrication performed. Similarly, more comprehensive schedules may be posted in strip shovels and preparation plants, or supplied to foremen and mechanics underground. In any event, the goal is to have something definite and thus avoid hit-or-miss application, buckpassing and the like.

Application

A key item in lubrication is getting the job done. Responsibility may be placed on the maintenance department alone or may be shared by the maintenance department and the machine operators and/or section or pit mechanics and electricians. The lubricating system varies with the type of machine and when and where it is used. The three general systems are:

1. Hand Lubrication. This usually involves grease guns or spout-type or other oilers for fluid lubricants. Where this is the practice, lubrication normally is handled by either the machine operator or the mechanic or electrician assigned to the machine or section, or by a special oiler, as with large stripping units. Lubrication can be combined with inspection and running maintenance, as with belt conveyors underground, for example.

SHOVEL NO. _____ **SMALL SHOVEL LUBRICATION RECORD** MONTH OF _____ 19

DAY OF MONTH	1	2	3	4	12	13	14	15
AFTER INSPECTION OF LUBRICATION WORK IS COMPLETED, SHOVEL OPERATOR AND PIT FOREMAN MUST SIGN REPORT. IN ABSENCE OF PIT FOREMAN, LOADING FOREMAN SIGNS FOR LUBRICATION WORK COMPLETED USE CHECK (√) SIGN SHIFT	12 01 8 am 4 pm	12 01 8 am 4 pm	12 01 8 am 4 pm	12 01 8 am 4 pm	12 01 8 am 4 pm	12 01 8 am 4 pm	12 01 8 am 4 pm	12 01 8 am 4 pm
HOURS OR MINUTES DEADHEADING								
HOURS OPERATED LOADING COAL, ORE, ETC.								
PARTS LUBRICATED PIT NO.								
(1) Truck Frame and Propelling Machinery (Lower Works)								
All Fittings Below Deck Lubricated								
Circle Rollers Lubricated								
All Cat Assembly Fittings Lubricated								
Propel Bearings Lubricated								
Open Gears and Sliding Surfaces Lubricated								
Enclosed Gear Case Oil Level Checked								
(2) Revolving Frame and Machinery Units (Upper Works)								
All Fittings in House Lubricated								
All Open Gears Lubricated								
Enclosed Gear Case Oil Level Checked								
Hydraulic Oil Level Checked								
Gasoline or Diesel Engine Oil Changed								
Light Plant Oil Changed								
Electric Motors and Generator Bearings Lubricated								
Flexible Couplings Lubricated								
Air Compressor Oil Changed								
Air Filters Cleaned								
(3) Front End Equipment								
All Boom Fittings Lubricated								
Boom Support Cables Lubricated								
Hoist Cables Lubricated								
Open Gears and Sliding Surfaces Lubricated								
Enclosed Gear Case Oil Level Checked								
All Bucket Fittings Lubricated								

(1) TRUCK FRAME AND PROPELLING MACHINERY	PART	HOW OFTEN TO LUBRICATE	TIME TO LUBRICATE
PARTS TO BE LUBRICATED:			
Drive Tumbler Shaft and Transverse Propel Shaft Bushings.	Point Sheaves	3 times per shift	1. Start of shift
Longitudinal Propel Shaft and Propel Brake Shaft Bushings.	Crowd Fittings	3 times per shift	2. Two hours after starting
Center Pintle Thrust Washer Oil Pump (Note Instructions On Pump)			3. At lunch time
Center Pintle Bearing Bushing.			
Take-Up and Idler Tumbler Bushings.			
Steering Clutch Shifter Collars.	Fittings in House	2 times per shift	1. Start of shift
Steering Clutch Sliding Jaw Guide Bars.			2. Middle of shift
Propelling Bevel Gear Cases.			
Cat Side Frame Gear Cases	Circle Rollers	1 time per shift	1. Start of shift
Swing Rack Teeth			
Roller Track Bars.	Cat Assemblys	Mud and Water Conditions 3 times per shift	1. Start of shift
Roller Pins.			2. Two hours after starting
			3. After lunch time
(2) REVOLVING FRAME AND MACHINERY UNITS (Upper Works)			
PARTS TO BE LUBRICATED:		Dry Pit Conditions 2 times per shift	1. Start of shift
Vertical Propel Shaft and Upper Propel Shaft Bushings.			2. After lunch time
Propel Bevel Gears and Sliding Propel Gears.			
Hoist Pinion Sleeve Bushings.		Deadheading Every 1,000 feet	1. Start before deadheading
Hoist Gear.			
Drum Shaft Bearings			
Intermediate Shaft Bearings			
Intermediate Reduction Gear Case.	Open and Partially Enclosed Gears Sliding Surfaces	Normal Operating Conditions 2 times per shift on loading	1. Start of shift
Vertical Swing Machinery Gear Case.			2. Lunch time
Vertical Swing Shaft Lower Bushing		Deadheading As often as dry spots appear, or approximately every 1,000 feet	
Electric Motors and Generators			
Hydraulic Pressure System			
Operating Lever Shaft Bearings, Bell Cranks.			
(3) FRONT END EQUIPMENT	Hoist Cables	Every 24 operating hours, Never let hoist drum cable grooves run dry.	When convenient When dry
PARTS TO BE LUBRICATED:			
Boom Point Sheave Bushings.			
Shipper Shaft Bushings.			
Saddle Block Bushings	Boom Support Cables	Once a month	While machine is idle
Dipper Handle and Saddle Block Slide Plates.			
Shipper Shaft Gear Case.	Enclosed Gear Cases	Check oil level once a shift	Start of shift
Intermediate Gear Case.			
Intermediate Shaft Bearings.	Hydraulic System	Check oil level once a shift	Start of shift
Dipper Padlock Sheave			
Dipper Door Hinge Pins, Padlock Pins, Ball and Handle Pins	Air Compressor	Check oil level once a shift Clean air filters and change oil once a month	Before starting
Wire Ropes			

Center Pintle thrust collar at lower end is lubricated by hand pump on truck frame at idler tumbler end. Operate pump plunger two or three times, twice a shift.

GASOLINE OR DIESEL OPERATED MACHINES: Clean air filters, change oil and filters each 100 operating hours. Always drain while oil is hot.

Always wipe off grease fittings to avoid forcing dirt into bearings.

Shovel operator, pit or loading foremen will be held responsible for checking lubrication work done during their shift, also the keeping of monthly lubrication record chart on shovel up to date.

Pit or loading foremen and operator are to sign record chart at end of their respective shift.

It shall be the duty of day shift pit foremen to see that there is enough lubricating materials and equipment on shovel to carry over the afternoon and midnight shifts at all times

Inspections of mechanical and lubrication conditions of shovel will be made by maintenance supervision and lubrication engineer during all shifts.

Lube Engineer

GOOD LUBRICATION MEANS

- SAFETY
- LOWER OPERATING COSTS
- FEWER SHUT-DOWNS
- MORE PRODUCTION
- JOB SECURITY

LUBRICATION EFFICIENCY is promoted by definite scheduling and reporting, as with this form for small shovels.

Hand lubrication involves more transfers and containers, as a rule, and makes for more complicated distribution in addition to increasing the risk of contamination. In view of this, one company (*Coal Age*, May, 1956, p 68) maintains central storage tanks (in old mine cars) at central points in working sections. The tank is filled from a large oil car by the supply crew, and is pumped through a hose to a convenient point near the face units.

An improvement in small hand gun reloading is the use of manufacturer-filled grease cartridges, which reduces the reloading time and eliminates contamination.

2. Lubricating Trucks and Special Crews. Such trucks are used both underground and at strip pits. Hand lubrica-

tion may be desirable for several reasons including low working height, cramped quarters, or the type of unit, such as, a belt conveyor. However, since individuals with other duties frequently are called upon for lubrication under this system, the chance of human error is greater. Hand lubrication also increases the chances of contamination, and may require stopping the units during the working periods, thus reducing output.

The preceding are among the reasons why a number of mines have placed responsibility for lubrication on special crews and have provided them with lubricating trucks. A typical underground truck usually is operated by a crew of two men, who visit all units in the mine or a section of the mine once a day on the off shift. The truck usually is equipped with tanks for two types of lubricants, with a third tank for hydraulic oil, and may be provided with hoses for blowing fittings, motors and the like as necessary with air from the compressor used in dispensing the lubricants. Where the truck is track-mounted and offtrack equipment is employed, the offtrack equipment may be brought to the loading station once a week, for example, for thorough inspection and lubrication, with lubrication by hand at other times. The truck crew also fills lubricant containers for hand lubrication.

As for results, one mine bought a truck to serve eight loaders and nine cutters, and in the first 18 mo of use had only three bearing failures. Lubricant consumption was reduced 65% in the same period. Another mine using a truck reports that a loader can be greased completely in 10 min.

Trucks for strip equipment also may include fuel-dispensing equipment. One such unit comprises a gas-powered compressor, lubricating pumps, for lubricating hoses on reels, and four fuel drums with the necessary hoses. Air pressure is used for dispensing fuel as well as lubricants, and the unit serves tractors, drills and other smaller mobile units.

3. Centralized Automatic Lubrication. Minimum manpower and positive lubrication at all times are among the reasons for the rise in use of centralized automatic lubricating systems in coal mining. These systems dispense either grease or oil—more usually grease—and among other advantages reduce the chances for contamination to almost nothing, since the lubricants usually are dispensed from the original containers or if not, with a minimum number of transfers. Applications of centralized automatic systems include:

1. Loaders, cutters, continuous miners and shuttle cars underground. In some instances, the systems are designed to give the bearings a shot whenever the machine hydraulic system goes through a cycle, thus requiring no manual attention whatever. Some, however, prefer to leave part of the lubricating cycle to the operator because with automatic initiation there is the possibility of overlubricating, with grease getting into, for example, motor windings.

2. All bearings in preparation plants, with the possible exception of motors. Automatic systems, in fact, have included dispensing of grease to underwater bearings on sludge conveyors.

3. Heavy-duty off-highway trucks, including wheel and steering bearings. For a description of how it is done at one operation, with substantial savings in truck time, lubricants and replacement parts see *Coal Age*, August, 1955, p 60.

4. Large stripping shovels and draglines, and possibly other smaller units. One company divides between hand and automatic lubrication of stripping equipment on the basis of (a) cost of special lubricating equipment v. the type of machine and its expected life, and (b) the fact that in many instances the man still would be necessary. Other major factors in this company's program (*Coal Age*, January, 1952, p 76) include lubricant standardization, detailed scheduling of lubricant application, reports on lubricant application, and prevention of contamination.

Results reflect (1) a reduction in the cost of lubricating materials—from 3.05c per ton in 1944 to 2.20c in 1950, in spite of increases in material cost, (2) a reduction in maintenance expense, and (3) a reduction in the losses in production time. The program includes both pit and preparation equipment, and at that time the reduction in cost of maintaining stripping equipment was estimated at $75,000 a year, and of maintaining a dry preparation plant (centralized lubrication), $20,000 a year.

SEALS AND FITTINGS—Effective lubrication, in addition to all the other factors involved, depend upon (1) the lubricant getting into the bearing, and (2) the lubricant staying in the bearing. Therefore, fittings, oilers, grease cups and the like must be of the proper type and must be in condition to function as needed. Otherwise, no lubricant. A No. 1 job of any men handling lubrication therefore is to check to make sure the fittings and lubricators are in operating condition, and to report promptly if they are not in shape.

Bearing seals are unglamorous but nevertheless are vital to make sure that the lubricant is retained so that it is available for the job it is called upon to perform.

Reports and Records

Unless somebody checks, adhering to an efficient system in lubrication, as in all other activities around the mines, is practically impossible. This means reports and records which, even though they involve paper work, provide the basis for intelligent operation and control.

Reports may be rather simple in nature, merely recording that a certain machine was lubricated on a certain date. An important item in any report, however, is whether certain bearings refused to take lubrication or took too much, since this is a signal that trouble is probably in the making. A rise in quantity used on each machine or in each application is a further signal that machine condition is deteriorating, or that certain parts need attention. And if experience has shown that adequate lubrication can be secured with certain quantities of materials, figures on quantities used also will reveal waste and loss through contamination or otherwise.

Rated Voltage

IT IS DIFFICULT to overemphasize the importance of rated voltage at the motor terminals as a factor in maintenance—and in unit production. DC motors, for example, tend to slow down almost in proportion to voltage drop, and slow-acting machines, plus frequent cable and armature failures, tend to result in don't-care operators.

When trailing cables or motor conductors are subjected to high current overloads—one result of reduced voltage—the resistance of the copper conductors increases, the cable drop rises, the voltage to the machine is further reduced, the machine automatically calls for more current with added heating, and the vicious circle continues—possibly to the point of cable or motor failure. Under extreme conditions, copper can be heated to 600 F or higher, at which point it will burn even if nothing else fails before.

As an example of what can happen, consider a 50-hp motor, 0.85 efficiency, served by a 1/0 cable 300 ft long and trying to do the same work at 270 and 180 V. The extra current loss in the conductors at 180 V could approximate 0.4 kw. On this basis, the extra heat generated in 1 hr is equivalent to between 6 and 7 lb of coal. It is almost the equivalent of operating a household stoker inside a jacket of cable or motor insulation.

Maintaining Voltage

Admittedly, the preceding is an extreme case, although not unknown in actual operation, where heat has been known to cause trailing cables to almost explode into flame. It points up, however, the need for maintaining rated voltage at machine terminals, especially in view of the higher horsepowers being crowded into motors used on face machines, and into others as well.

The causes of low voltage include:

1. Substations too far from the working face (see article on electric power beginning on page 261 of this issue for recommendations on maximum distances).

2. Excessive cable length.

3. Inadequate feeder and return capacity.

4. Cables too small.

In addition, excessive heating results from the following:

1. Layering on reels or in piles decreasing cable rating because of inadequate air circulation.

2. Inadequate or no overload protection. Properly rated fuses or properly set circuit breakers should be used.

Regular voltage checks therefore become a necessity in preventive or production maintenance, and may even warrant the use of recording-type instruments at strategic locations. Otherwise, the section electrician may well be charged with the responsibility for making regular checks. And to make these checks effective, a program of moving up substations and beefing up feeders and returns as necessary must be followed. This might well be the responsibility of the chief electrician, maintenance supervisor or electrical engineer.

Since even under the best of conditions heat is generated when current flows in conductors, and the higher horsepowers now being employed in the same or only slightly larger space aggravate the problem, the best in motor and cable insulation should be employed, such as asbestos-fiber compounds, silicone and the like. Blowing motors is a well-established method of keeping them cool in certain types of service, and cooling by water jackets is coming into the picture for certain motors subjected to the most-severe duty, as on continuous miners.

Cable Maintenance

Even with rated voltage, delivery of the necessary power to the operating machines usually involves a trailing cable of some type. Aside from low voltage and overload, the major causes of cable failure, particularly underground, are:

1. **EXCESSIVE TENSION** – Install spring-type shock absorbers, keep proper tension on reel, adjust reel to prevent back spooling.

2. **MECHANICAL DAMAGE** – Avoid running over cables, replace broken sheaves and guides, avoid pinching cable.

Additional data on failures and their causes appears in a comprehensive discussion of cable types and cable maintenance in the December, 1953, issue of *Coal Age*, p 75.

In the event a cable fails in spite of all precautions, reducing the time lost requires quick restoration of the service. Some ways of doing this are:

1. Use of compression connectors and special hand or power tools for quick connection of the power and ground wires to save time. Special portable welding equipment also is used to make splices electrically in the section (*Coal Age*, January, 1951, p 70). A fairly common failure is trying to keep a cable with too many splices or otherwise in less than top-grade condition in service. The cost of the delays in some instances will repay the cost of a new one in as little as 2 to 4 days.

2. Use of spare cables to permit quick replacement of the entire cable. An alternative with at least certain types of equipment is the use of sectionalized cables, which not only are easy to install but also lend themselves to the quick replacement of a new section for one that has failed.

Temporary splices should be kept to a minimum. One rule allows six, after which the cable is removed and sent to the shop for rebuilding by permanent welded or compression-connected splices and vulcanizing. Some mines remove the cable with a lesser number of splices. At certain operations where attendants are required at substations or other facilities, these men are provided with the necessary repair and vulcanizing facilities and take care of splicing, vulcanizing and other cable maintenance, thus saving the wages of a specialist.

FAULT-FINDING – Failures in long high-voltage cables, such as on strip shovels, can result in a long search for the trouble point, with attendant loss in production time. Electrical fault-finders now on the market cut this time loss to a minimum by giving a quick and accurate indication of where the failure occurred. Or, the mine can make its own (*Coal Age*, May, 1953, p 108).

Maintenance Materials

HARDSURFACING PRODUCTS are an example of materials that cut maintenance cost by increasing the life of machines and parts subject to wear, reducing the number of replacements and consequently saving not only in parts and materials but also in labor for replacement.

Examples of the other materials and parts that may be employed to lengthen machine and part life, reduce breakdown time and cut the cost of maintenance include:

1. Stainless and other alloy steel, aluminum and so on for strength, light weight and corrosion resistance in mine cars, truck bodies, stripping dippers, cages and skips, and so on. Light weight, provided there is the requisite strength, in itself reduces the maintenance load, or light weight with high strength permits building up parts without increasing total weight, thus reducing the chances of failures.

2. Stainless steel, manganese-steel and bronze for reducing wear and corrosion in coal screening and other coal-handling processes.

3. Special alloys, bronze, rubber, other corrosion- and abrasion-resisting materials for pumps, valves, fittings and other equipment handling water and water with various solids.

4. Use of lime, by means of automatic feeding equipment, in wet-preparation plants where acid is a problem to reduce corrosion.

5. Cast iron, alloy, asbestos-cement, lined or plastic pipe for mine and other water lines to resist acid.

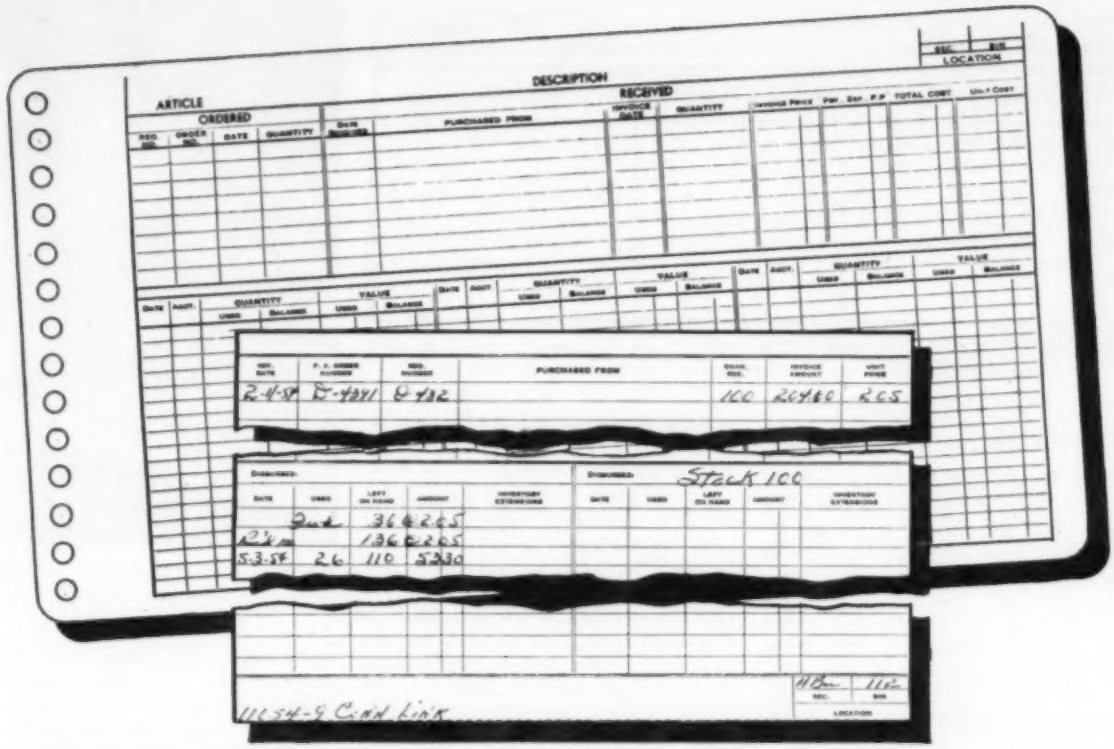
6. Rubber, tile, sprayed and sand-cement and other corrosion- and abrasion-resisting materials for tanks and storage bins. Some companies have made complete bins of steel-supported glazed tile to resist the effects of abrasion and corrosion.

7. Glass, stainless steel and other wear-resisting materials for chutes, conveyor bottoms.

8. Aluminum, protected-metal and other weather-resistant siding and roofing for preparation plants and other structures.

9. Protective coatings and paint where needed.

10. Silicone, asbestos and other long-lived heat-resistant insulation for electrical equipment.



PERPETUAL-INVENTORY CARDS are for loose-leaf ledger and tray-type files. A complete record of supply receipts, quantity on hand, disbursements and costs requires only two forms, thus simplifying inventory and minimizing clerical work.

Profitable Supply Control

Goals

Eliminate production interruptions resulting from lack of parts and materials.

Keep inventory to a minimum.

Minimize parts and materials handling.

Control waste and loss of parts and materials.

Ways and Means

Establish a good inventory control system, such as, the perpetual inventory.

Compile detailed reports on the use of parts by each major machine.

Keep an adequate supply of items on hand that are essential in controlling the cost of coal production.

Regulate supplies by reordering on time.

Plan storage layout for efficiency, convenience and protection.

Provide necessary parts and material at or near the point of use.

Make studies to determine type and quantities of supplies.

Provide facilities for supply delivery on the surface and underground for quick delivery with minimum labor.

Reduce waste and loss of parts and materials by setting up rules and standards and following through.

Where to Find It . . .

Control Systems . . . . . p 330
Perpetual inventory . . . Supply receiving . . . Physical inventory

Records and Reports . . . . . p 330
Account numbers . . . Order forms . . . Monthly distribution reports . . . Special reports

Inventory Control . . . . . p 331

Storage and Handling . . . . . p 332
Storage layout . . . Supply-house facilities

Allocation of Stocks . . . . . p 333
Equipment requirements . . . Central warehousing system

Special Supply Houses . . . . . p 334
Powder magazines . . . Oil houses . . . Sand houses . . . Portable supply houses

Supply Delivery . . . . . p 335
Delivery schedules . . . Surface delivery . . . Underground delivery

Preventing Waste and Loss . . p 336
Key factors . . . Salvage

ACCOUNT NO. LOADERS – 1–101

SHEET NO. _____

REPORT OF MATERIALS AND SUPPLIES USED AT _____ MINE FOR MONTH OF _____ 19____

DESCRIPTION OF MATERIAL AND SUPPLIES USED	QUANTITY USED	UNIT PRICE	SUB-ACCOUNT NUMBERS								
			LOADER #1	LOADER #2	LOADER #3	LOADER #4	LOADER #5	LOADER #6			
TOTAL											

MONTHLY USE REPORTS such as this lend themselves to summaries by account or function numbers, or by individual units to keep track of parts costs.

Control Systems

COAL MINES SPEND an average of approximately 85c per ton for supplies alone. The low, usually at the smaller operations, is as little as 40c per ton or less and the high is over $1. These figures show why supplies are an important item in a good cost-control system (*Coal Age*, April, 1958, p 78) and in turn the need for a good supply system, close inventory control and more detailed reports on the use of parts and materials by machine and by working sections.

Perpetual Inventory

Companies have largely settled on the "perpetual" system of inventory control. Basically, it provides a running record of (1) quantity and cost of units and materials received, (2) quantity and cost of units and material issued, and (3) quantity remaining on hand at all times.

This information is contained on cards at each bin or on tray-type cards filed in loose-leaf ledgers or metal cabinets.

FILE CARDS—The file-card system is the handiest and surest method of inventory control. It reduces the possibility of running short of supplies through failure to note that the time for reordering has come.

Inventory cards may be made up specifically by a mining company to meet its own needs, or cards, files and systems may be purchased from specialists in business machines and business records, who can, if desired, provide forms and equipment for even punch-card tabulating and record-making where the number and volume of supply items is large.

The accompanying illustrations show two types of cards provided by business-record specialists. One is designed for ledger use and the other for tray-type files. Both give a complete record of each supply item.

RUNNING RECORDS—The system provides a running record of activity in supplies, and also an easy means of making periodic summaries of use. Most companies prefer to have all supply items listed in the system. However, when there are exclusions, such as timber, it becomes necessary to make sure that (a) the items are not overbought, (b) that the quantity is not permitted to drop below the danger point, and (c) that data are supplied for the periodic supply-use and inventory reports.

REORDER AND USE INDICATORS—To facilitate reordering and filing reports on the use of parts, supplies and materials, cards with "flags" or colored tabs can be used.

A green plastic tab, for example, on the card may be slid to the center the first time an item is issued in a monthly or other report period, and a red tab on the opposite side also may be slid to the center as an indication that the item is to be reordered when the next requisitions on the purchasing department are prepared. The flags make it unnecessary to check each card for either preparation of the distribution report or for reordering.

Supply Receiving

A new receiving system (*Coal Age*, September, 1957, p 73) eliminates delays in reporting receipt of shipments, which result in the delay of payment of invoices with the possibility of missing out on discounts. All necessary papers are prepared in a single writing by means of a portable register. It consists of four parts:

White — Invoice clerk's copy with freight or express bill attached.

Green—Cost clerk's copy.

Blue — Requisitioner's acknowledgment.

Salmon — Requisitioner's copy for filing.

Physical Inventory

Accurate records of receipts, cost and use are essential for wise and economical use of supplies. Regardless of the supply control system employed, it should be supplemented by an actual physical inventory if supply cost and production time are to be reduced. Inventories are usually taken at 6- and/or 12-mo intervals.

HANDY DESK equipped with filing compartment is used for parts catalogs.

Records and Reports

THE STANDARD "supply-distribution report" and detailed reports on the use of parts and materials by machine and by working section are increasing in importance. For convenience, each equipment class or mining function is provided with an account number.

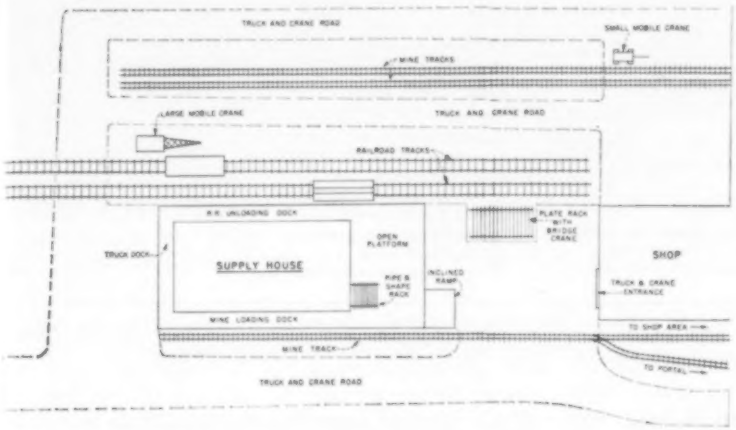
ACCOUNT NUMBERS—The daily or other delay reports using account numbers provide—at least by inference—sufficient information to determine whether supplies are being used properly and economically. On the other hand, the more detailed system requires definite and positive information to prevent waste and loss through abuse and carelessness.

ORDER FORMS—Order forms, reports and records are essential for the proper evaluation of supply use. Nothing should be issued without an order, properly signed, stating what is wanted and where it is to be used. For a check and appropriate action, summaries of supply use should be prepared at regular intervals for the information and use of mine and operating management.

MONTHLY DISTRIBUTION REPORTS—This is one form of report to mine and operating management. Where more detailed data are desired the form or forms may be expanded to show items charged out to each machine, to each working section and to each general function, thus indicating whether abuse is running up parts cost or whether certain sections are taking more supplies than necessary.

SPECIAL REPORTS—These reports may be required of certain officials and mine employees. For example, a single carbide-tipped cutter bit can cost $1.25 or more and, therefore, some operators feel that it is necessary to keep records on the amount used daily and the number on hand. Similar records could be required for other small and relatively costly items, such as, roof bolts, steel ties and the like.

To wrap up a detailed record system, it naturally should show transfer of certain materials from one working area to another, thus guarding against possible loss through carelessness or buck-passing. And if such things as timber are salvaged for use elsewhere, the records should show how much came out of a particular section and where it went as a means of gaging, among other things, the effectiveness of a salvage program.



Storage Layout

CONVENIENCE, EASY ACCESS AND PROTECTION feature yard designed for truck and mobile-crane operation with receiving and loading docks on three sides. The principles illustrated include:

1. Receiving and loading dock completely surrounding the warehouse. This is a practice that can be followed if desired, but it may not always be necessary to surround the supply house with docks, though provision should be made for sufficient dock space both for receiving and for loading mine equipment. The docks in the setup illustrated are at the right height for receiving material from railroad cars or trucks, and for loading materials into mine equipment without excessive lifting or lowering.

2. Open storage planned so that as heavy material is unloaded it can be placed so that it is convenient for loading into mine equipment. Roads are located so that mobile cranes can be used for unloading railroad cars or for lifting heavy items out of storage into mine equipment. These same roads permit unloading such items as mine props and timbers directly to the mine trucks if desired.

3. Use of power-operated handling equipment. The mobile crane, with various attachments, including clamshell for sand and gravel, and fork for props, rails and the like, or other mobile handling units materially reduces labor and also the hazards involved in handling heavy parts and materials. With a fork-type grab, for example, two men can load a car of ties in less than 1½ hr. Aside from cranes, mobile handling units include motorized wheelbarrows, motorized high-lift, bucket-type loaders and carriers, high-lift fork trucks, crane trucks and so on.

4. Open platform with inclined ramp provides open storage for certain parts and materials and also makes it easier to get equipment, such as, shuttle cars, loaders and the like out of railroad equipment and down to mine-track level. Handling of heavy items on the platform can be done with the mobile cranes, or the platform can be equipped with crane rails and a hoist. An alternative is a crane track extending out of the supply house to the platform both for handling materials on the platform, or for moving them inside to floor storage.

The plan illustrated also shows an open plate storage with traveling crane and hoist. Plates are stored on edge between stanchions.

Inventory Control

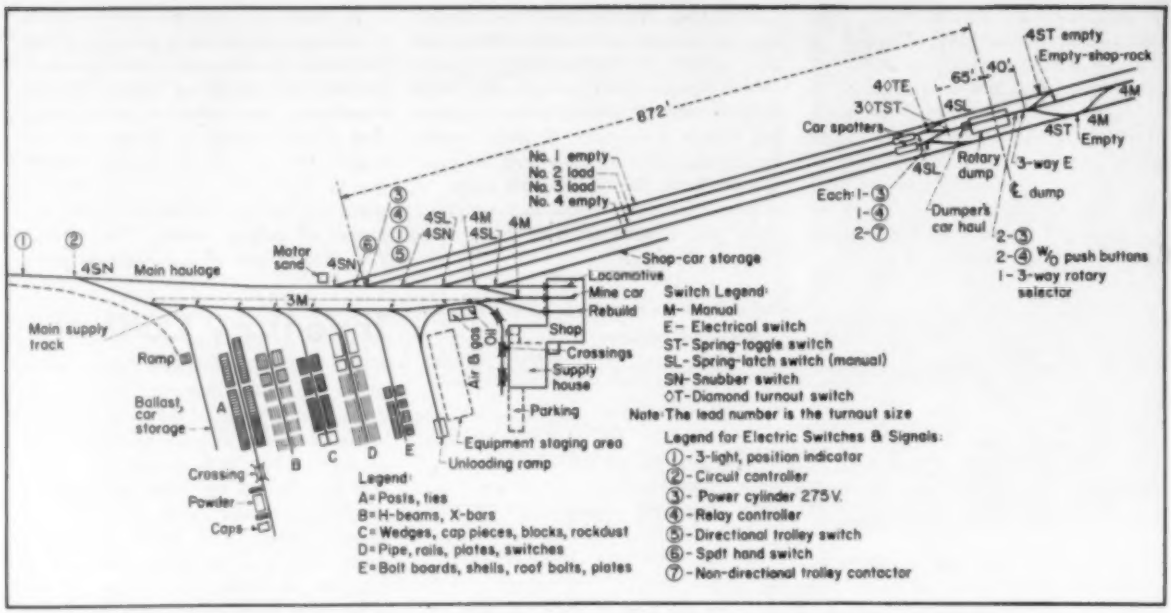
THE QUESTION most often asked about supply inventory is: "What should be carried in terms of dollars and cents?" Actually there is no one answer. Inventory, if too high, means that money will lie idle. On the other hand too low an inventory can mean increased production delays and higher production costs. Among other things, the level of supplies at individual mines depends upon mine location and size. Inventories range from as little as $25 to $30 per ton of daily capacity up to $150 or more per ton at mines remote from manufacturing and distribution centers. The average appears to be in the neighborhood of $50 to $60 on hand per ton of daily capacity.

Control Factors

The inventory level involves a fair amount of personal judgment based on experience and an analysis of parts and supply use in relation to time for normal replenishment. Some of the factors involved in arriving at a solution include:

1. Cost of item or a class of items in relation to production cost increases incurred if the item is not on hand when needed—for example, spare armatures or motors. For instance, how much, at the most, would a rotor failure on the main shaker-screen motor involve in payments for nonproductive labor, for power for ventilation and pumping during the production interruption, and so on? And would the cost be reduced if a complete motor was on hand instead of only the rotor? Or should the possibility of a stator failure be the controlling one and thus dictate keeping a complete motor ready for replacement?

2. Rate of use in relation to time required to reorder and get delivery of replacements. Experience normally will indicate the rate at which, say, controller fingers of a certain type are used. If new supplies could be secured in a month, then the maximum on hand at any one time theoretically would be a month. Or, the total use in, say 6 mo, might be so small that it would pay to keep that much stock on hand to avoid



SUPPLY YARD has tracks running to areas assigned to specific items. Loading is simplified with power crane. Four mine-car tracks permit storing or blending of raw coal. Supply house and shop are strategically located.

the extra clerical and other effort involved in ordering more frequently—not to mention discounts for large orders.

3. Central warehousing vs. warehouses at individual mines. Where one company operates several mines, it normally is considered more economical to operate one central warehouse provided certain conditions exist. These include:

A. Reasonable distances from central warehouse to mines to keep down delivery time.

B. Good highways and good trucking facilities to permit fast deliveries.

Where these conditions exist, central warehousing, as noted, is considered feasible and economical, except for certain types of supplies, such as, timber, rail and the like. Of course, a certain volume of other parts and supplies must be kept at each mine and, in fact, at each deep-mine or pit face, to facilitate maintenance and prevent operating delays arising out of such things as lack of timber, etc.

4. Cooperative stocking. Where a part or a component is large and costly and requires considerable time to repair or, if completely wrecked, must be manufactured from scratch, it is possible for a group of companies in an area to buy one such component or part and rotate it around as needed.

5. Independent warehousing. Where manufacturers, their agents and independent supply houses have branch or main establishments close to the coal fields, maintain stocks of the desired items and provide quick delivery, it is possible to use them as the source for many items, thus cutting down on both inventory and on company-owned warehousing facilities.

6. Price trends. If one is willing to risk the hazards of estimating future trends, it may turn out to be desirable to run up the inventory of parts and supplies—at least in part—to offset expected price increases, or to curtail purchases in anticipation of decreases.

Storage and Handling

TYPE, SIZE AND COST of specific items normally dictate methods for receipt, storage and issuance. Thus, depending upon these factors, both enclosed and open storage are employed at mines. Enclosed or covered storage includes both regular supply buildings and also sheds for certain items requiring less protection.

Open or yard storage is satisfactory for timber, steel ties, rail and the like including heavy equipment items that are not appreciably affected by rust and other deterioration as a result of exposure to rain, snow, dust and the like. Where the items are made, for example, from copper and lend themselves to theft, enclosed storage normally is dictated to prevent losses of this type. Shed storage may be desirable for pipe structural shapes, plate and the like to prevent excessive rusting and also avoid difficulties with snow and rain in storing and handling. However, shed storage rules out, in most instances, the use of mobile cranes in handling such items, and the ability to use such equipment may outweigh the disadvantages of open storage.

Storage Layout

While the storage layout will vary from mine to mine, the plan shown in the accompanying diagram illustrates some of the basic principles involved in achieving efficiency, convenience and protection. In this instance, the shop is near the supply house and thus a separate shop supply is not required.

Supply-House Facilities

Supply houses include both bin storage for small or moderate-sized items, and floor storage for heavier units. The floor-storage facilities at one new supply house include a basement for cool storage of rubber-covered cable, conveyor belts and other rubber items. Access to the basement is by 25-ton hydraulic lift, large enough to handle even the heaviest reels of cable and belt, which can be rolled on and off.

Some supply houses include a monorail and hoist for handling heavy units into and out of the floor-storage area, and storage facilities for such heavy items, include, in addition to open floor, racks for, say, spare armatures.

Other facilities which have proved

MECHANIZED EQUIPMENT speeds unloading of roof-bolts from truck into cars and eliminates the need for adding extra men to the detail.

REELS FOR CABLES facilitates storing, handling and measuring out pieces.

successful in simplifying the handling of supplies in warehouses include: sectional steel bins with adjustable shelves; drawertype and rotating bins for small items; clear plastic chest and drawer units for miniature units; shafts and reels mounted on walls or stanchions for convenience in paying out and measuring cable, hose, rope, etc.; peg racks for V-belts and similar items; and platform-top push trucks for moving items to and from bins, especially if the warehouse occupies a rather large floor space.

If bins are built up higher than eyesight level or arm's reach, trolley or wheeled ladders or steps save time and reduce the possibility of injury. One wheeled step, for example, includes springs which give when a man puts his weight on the steps and thus provides solid footing.

Light should be ample to read tags, nameplates and the like, and the sources should be placed so that it is relatively easy to see into the backs of shelves or bins, especially those high up.

Other ideas employed to facilitate storage and handling include: Easy access to bins, for safe and quick disbursement of parts by the use of permanent stairways and balconies. Monorails equipped wih hoists and armature racks mounted on wheels (see illustration) save space and facilitate handling of heavy parts.

Allocation of Stocks

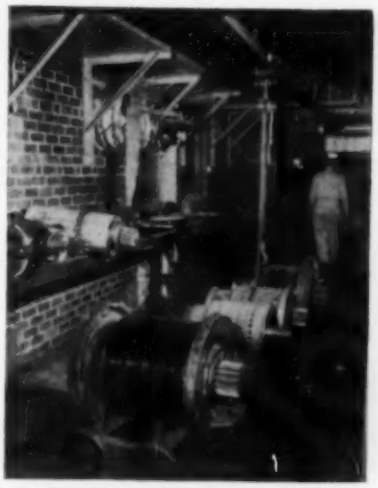
THE CARDINAL PRINCIPLES of stock allocation are: (1) make studies to determine type and quantities of parts and material necessary to keep production interruptions to a minimum, and (2) provide such supplies at or near the point of use.

Stocks of frequently used machine parts, for example, should be kept close to or in the pit or underground section for the use of the section or pit electrician or mechanic.

EQUIPMENT REQUIREMENTS—Once essential repair parts have been supplied, replacements for such stocks normally are charged to operating cost when they leave the main supply house. If it is desired, as discussed previously, to keep accurate use records, the section or pit electrician or mechanic can file reports showing use of items by machine number, thus enabling operating management to keep track of where parts and materials go. Rather than a separate report, the section mechanic's or electrician's daily delay and repair report can show what items are used and where.

CENTRAL WAREHOUSING SYSTEM—Where two or more mines are involved and the central warehousing system is employed, allocation might be along the following lines:

1. Principal stock of repair parts at the central warehouse.
2. Subsidiary stocks at the central repair shop, provided it is not adjacent to the central warehouse.
3. Subsidiary stocks at the mine shops.
4. Section stocks in the working sections or pits for running repairs and maintenance.
5. Stocks of ties, timbers, roof bolts and similar items at the individual mines, since it is more convenient and less costly to have such materials delivered directly to the mines for storage and distribution rather than rehandling them



MONORAIL AND ARMATURE RACK saves space and facilitates handling.

24-IN BOREHOLE cuts time in getting small parts underground.

MOBILE CRANE with various attachments handles heavy materials in the supply yard and can unload a car of ties in less than 1½ hr.

VERSATILE FLAT-BED TRUCKS facilitate supply delivery to working sections in coal mines. Note diesel-locomotive being used in supply yard.

SUPPLY CAR EASES HANDLING of conveyor pans, parts and supplies in thin seams and reduces emergency repair time by getting parts to the face quickly.

from a central point. In fact, even where only one mine is involved, it may be more convenient to provide separate facilities for receiving, storing and distributing (a) machine parts and smaller items, and (b) larger, bulkier items used every day the mine runs.

Special Supply Houses

POWDER MAGAZINES, oil houses, sand-storage and drying facilities, and even portable or semi-portable pit or mine houses are considered as special supply facilities.

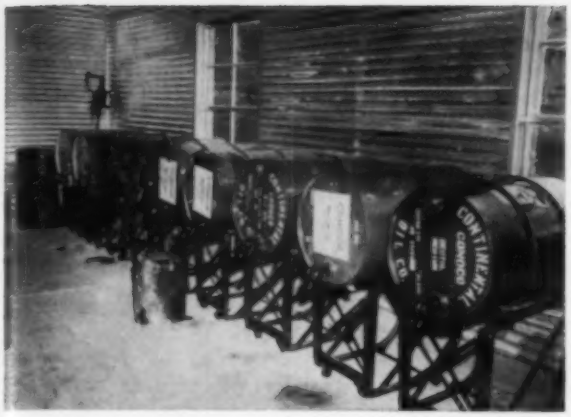
POWDER MAGAZINE—Design and location of this storage facility is a matter of following the recommendations of state and federal safety authorities and the Institute of Makers of Explosives.

OIL HOUSES—There is good reason for putting oil houses and oil-storage facilities apart from other surface units. However, there is no reason why they cannot be located for easy receipt of supplies either by truck or rail. As a matter of fact, convenient, clean and safe facilities for dispensing are as much factors in oil-house design as storage.

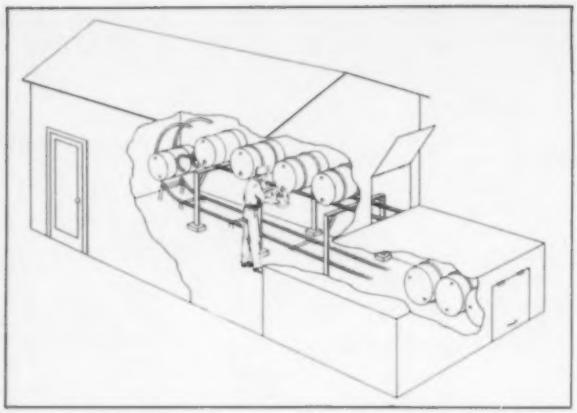
Designs most nearly meeting these objectives include: steel and concrete construction, racks that hold drums in proper position for dispensing, hoists or other mechanical facilities for handling drums, and provisions for catching drip and spillage. Fixed racks should be provided with inclined ramprails to permit rolling drums up to position, unless chain hoists are used. Chain hoists, incidentally, make it easier to replace drums without handling of others, as do tilting-type racks with castors, which may be pulled out of position, run to the storage area and tilted to permit taking off the drum, after which the process is reversed to put a new drum into position.

An example of a well planned oil house is shown in the accompanying illustration (Texas Co., "Lubrication of Coal-Mine Machinery"). Note that oil drums are delivered on a platform at truck-bed level. After drums are emptied they are rolled to the end and under the top rack to the outside.

SAND HOUSES—Terrain and other considerations affect sand-house design and location. If possible, the facilities should include storage for a specified number of truck loads. In hilly country, where sand is received by truck particularly, it may be possible to build the



OIL-HOUSE OPERATION is facilitated by such equipment as these caster-mounted tilting racks.



TYPICAL LAYOUT OF AN OIL STORAGE HOUSE permits easy handling of oil drums by one man.

oad up on the hillside so that trucks an dump directly into the bin.

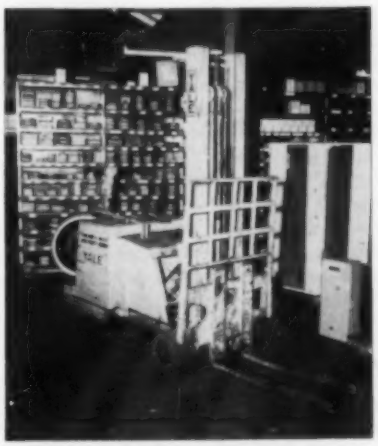
The preceding comments presuppose ravity flow from the wet storage bin to he drying stove or stoves, and from the toves or dry-sand bins to the locomoves, sand cars or bore-hole to the mineottom. This gravity flow materially reduces labor in all phases of receiving, rying and dispensing sand, and this aving may warrant a substantial investent in bins and gravity-handling facilies which, in some instances, are alost or completely automatic.

Though not yet possible in too many ining areas, sand-handling facilities ay be eliminated completely by depending upon outside suppliers for dryng and delivery. At one operation, the ustom drier delivers the sand in oiltype drums ready for movement into he mine.

PORTABLE SUPPLY HOUSES—Under certain circumstances, a "portable" supply house becomes quite convenient in addition to providing protection and promoting order in dispensing supplies—particularly machine parts. One circumstance is stripping where frequent moves are made from one location to another. Another is deep mining of the contour type, where the main opening keeps moving around the hill. Under such circumstances, a number of mining companies have bought small prefabricated buildings and mounted them on skids or trucks for towing from one location to another.

Supply Delivery

SURFACE AND UNDERGROUND DELIVERY is the last operation of a supply control system. The methods and the equipment employed to deliver supplies are determined by local conditions and the overall supply setup.



PORTABLE LIFT handles supply and equipment in shop and supply house.

Delivery Schedules

Delivery between supply house and shop where the two are not too far apart and are connected by a hard-surfaced roadway may be handled by hand-pushed lift cranes, motorized cranes or special motorized flat-bed trucks.

Supplies delivered from a central supply house to one or more mines usually are handled by motor trucks. It is important that order and delivery schedules be worked out. Requisitions from the various mines, for example, should arrive at the supply house at a designated time to permit the supply clerk to fill the orders before the supply crew is due to arrive.

Surface Delivery

The motor truck in its regular form is the work horse in supply and delivery on the surface. In its special forms, especially at stripping operations, it includes grease trucks—usually designed for actual application of the grease at the point of use as well—fuel trucks and utility trucks. And at some operations, the final stage in storage and delivery of explosives—at strip mines, for example—is handled by small rubber-tired units designed for towing on the bank by tractor, relieving the regular truck for other duties.

Underground Delivery

Where mine cars are employed to haul coal, the same track is used for delivery of supplies—perhaps to the face or, if trackless mining is the rule, to the point where the rails end. Even with belt haulage, convenience in handling supplies and men has led a number of operators to put supply tracks alongside the belt conveyor—or in a parallel heading. Battery locomotives may be equipped for pulling the equipment on such auxiliary track systems to avoid having to put up trolley wire. And in some instances, rubber-tired tractors and trailers are employed to take in supplies, eliminating track completely. With either system, the added convenience and saving in time and labor is held to warrant the installation of the track or the preparation of the special roadway for the trackless battery units.

Where belts are installed for haulage, especially single panel units, they may be provided with reversing facilities for movement of supplies back to the face. In some instances, at least, special inching and jogging controls have been provided to facilitate handling long cross-bars and other items without hazard to men or to the belt and conveyor.

Facilities for delivering supplies to the faces of rooms equipped with conveyors include:

1. Dolly trucks running in shaker lines.
2. False pan lines, or lines of pans

alongside the operating line, which are loaded with supplies and pulled up as the main line is extended, the face pan going into the operating line and the supplies to other face operations. At the same time, a new pan is added at the outby end and loaded with supplies until the place is halfway up, at which point the loaded line will complete the place.

In pitching places small hoists may be included in the equipment at the face to pull timber and other materials up from the track on the gangway below.

MOBILE UNITS—For the most part, unless pitch or some other condition prohibits, the mobile unit operating either on or off the track is the most efficient and flexible unit for supply delivery. In trackless areas, the mobile unit may be a shuttle car, though using a shuttle car on the working shift may result in interference with production. If supplies are delivered on the off-shift, the shuttle car may well double in brass. And if crawler trucks are used for moving shortwalls, these same trucks may also be employed for handling heavy units, such as motors, drives and the like. Special crawler-mounted pullers and carriers also have been built for moving drives and handling materials.

The extra advantages of special equipment, including availability at all times, design for handling materials and the like, have led, among other things, to a substantial growth in such equipment as battery powered tractor-trailer units, especially in trackless areas. Some mines also have used the equivalent of a straight truck with a battery for power.

For rail delivery, the mine car, as noted, still is the mainstay. However, special cars and trucks provide a number of advantages, including better design for loading, unloading and protection of materials and supplies. An example is the low-height flat-bed car with steel deck and holes all around for stakes which lends itself to handling almost any shape or size or material or part. Such cars are used on moderate-pitch slopes as well as on the flat. In tandem and properly loaded, such cars also can move rails and long timbers, though the special rail truck still is a standard item at most operations.

Other special cars which a number of operations have found advantageous include the following:

1. A utility car with a cab for the snapper equipped with plastic windows, and compartments for such items as steel ties, miscellaneous track and trolley supplies, coal augers, roof bolts and the like.

2. Sand cars especially designed for the service, including sides low enough for easy unloading to sand boxes.

3. Enclosed powder cars with sliding doors and insulated couplers.

4. Special insulated detonator cars with steel doors, wood and rubber lining and compartmented drawers.

5. Special ballast cars with bottom doors designed for spreading ballast in the track.

Special handling facilities at unloading or transfer stations underground can materially speed up the job and reduce the hazards. Oil drums, for example, may be lifted off trucks or out of cars by a small chain hoist and run back into the underground depot on a monorail. Similar facilities also may be installed for handling timber, roof bolts and other bulky, lengthy or heavy materials and parts. Handling is facilitated by bundling or typing the materials, such as, timbers, to make it easier to hook onto them with the hoist. In fact, some companies ask that lumber and certain other materials be bundled and strapped by the supplier to facilitate handling all along the line. Properly designed, underground stations of this type make it easy to unload and store materials until the face equipment is ready, then facilitate reloading for distribution.

Preventing Waste And Loss

IN VIEW OF THE COST of materials and supplies these days a carefully considered salvage program can result in major savings. Waste and loss, if not controlled, can play havoc with the supply budget. The operating department can contribute greatly to reducing waste and loss.

Key Factors

There is no particularly easy road to reducing waste and loss in parts and materials, but results can be achieved by, among others, the following methods:

1. **Good Records**—Where supplies go and how much (see "Records and Reports").

2. **Education**—Some companies have found, for example, that a display of certain supply items, each tagged with its cost and accompanied by some pertinent words by the superintendent or foreman, brings home to men the costs involved in loss or carelessness and consquently leads employees to handle materials and parts more carefully.

3. **Prevention of Machine Abuse**—This is largely a matter of training both operators and supervisors in how abuse results in breakdowns, lost time and an increased cost for parts.

4. **Rated Voltage**—Along with education of operators and supervisors, the rule should be rated voltage at the terminals of all machines, since less than rated voltage inevitably results in an increase in machine breakdowns, with attendant loss of time and increase in parts consumption.

5. **Protection**—Moisture in cement, coal dust in an open container of oil, and a bundle of roof bolts thrown along the rib and covered with loose coal are all examples of loss through failure to protect materials and supplies. The moral is enclosed storage for materials or parts subject to weather or water damage, enclosed containers for lubricants all along the line from receipt to point of use, and specific places for everything in the supply line—for example, special supply delivery points, with cabinets, chests and the like as necessary in every section for receiving and storing parts and materials. Indiscriminate dumping inevitably results in loss.

Salvage

The extent of salvage operations depends upon the value of the part or item in relation to the cost of getting it out and, if necessary, reconditioning it. Expending $2 on labor to recover something worth only $1 in the first place is, of course, out of the question.

Education is a major ingredient in an effective salvage operation. In other words, if men are encouraged to form the habit of picking up anything they see lying around and turning it in to a specific salvage station—on each section, for example—rather than walking by or, even worse, pitching things into the gob without thinking, the company benefits not only by the return of usable parts and materials but also from the scrap value of worn out items. Of course, each foreman should check on loose and misplaced materials constantly.

Certain items lend themselves to the use of organized salvage crews—for example, crossbar and post recovery. Equipped with mobile pulling units involving wire lines, chain slings and winches, such crews can, where safety considerations permit, recover several times their wages in posts and bars—as well as ties, rails and so on. A few mines have even used mine-detector-type equipment to find carbon-dioxide coal-breaking shells, steel ties and like buried in loose coal or gob in working places.

STAFF CONFERENCES to establish firm safety policies and directions and later transmittal of these policies to workmen through supervisors are essential elements in educating and training for safety. Top management must provide the impetus.

Making Mining Safer

SAFETY is more than an idea—it is a state of mind. It is more than a campaign—it is a crusade. The continuity of effective safety promotion, within a company, a region or the industry, demands the full support of top management and the cooperation of employees. The benefits will be — first and always foremost — the preservation of life and limb, followed by other returns such as higher morale, reduced labor turnover, lower compensation costs and higher efficiency.

The ways and means of achieving maximum safety are similar to those relating to other activities within the industry, particularly the technological pursuits. First, an approach must be made, and this includes defining the present status of safety performance, setting goals for the future and making plans for the attainment of these goals. Then, follow through in the execution of the plans is the day-by-day order of business.

Where to Find It...

Starting Points ..... p 337
Safety Organization ..... p 337
Training and Education .. p 339
Plant Maintenance Serves Safety ..... p 339
Keeping Interest Alive ... p 340

Starting Points

The steps in planning for improved safety performance are as follows:

- Organize for safety, employing all available skills to the fullest degree and enlisting all interested parties.
- Train and educate for safety, using planned programs for workmen, supervisors and management.
- Maintain the physical features of the mine and its surroundings in the approved manner to eliminate conditions which might lead to injuries.
- Keep interest alive through a continuous program of safety incentives.

From these starting points the "follow through" should proceed like this:

Safety Organization

The type of organization depends upon the job to be done. Within the company there are a number of functions to be performed. Someone must head up the program, someone must inspect the workings, the ventilation system must be patrolled, training must be conducted, and so on. If the company is small all these responsibilities may be handled by one man. In larger companies operating a number of deep and strip mines and cleaning plants the safety department may include one or more qualified men to fulfill each of the functions that must be served.

PROPER STAFF—The important requirement is that some provision be made

Field Reports

Photography for Safety—Injury situations are set up for the camera to provide hard-hitting safety promotion displays. *Coal Age*, October, 1958, p 124.

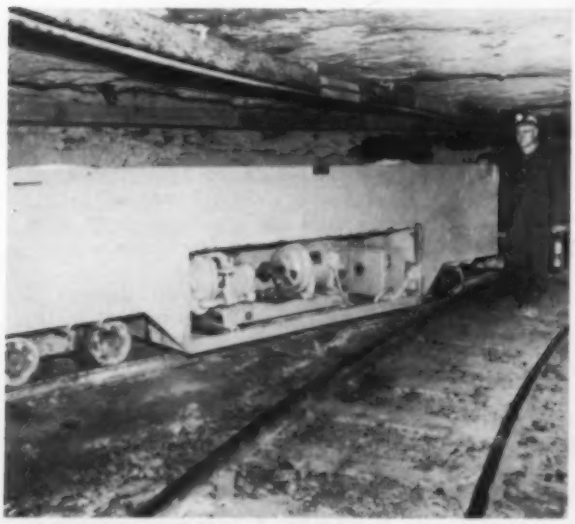
Follow Through—Constant accent on safety in daily operations marks operations at the Nation's safest bituminous coal mine. *Coal Age*, August, 1958, p 100.

Designing for Safety—Safety in operations is considered in planning roof support, haulage, ventilation and other elements at a new mine. *Coal Age*, September, 1958, p 92.

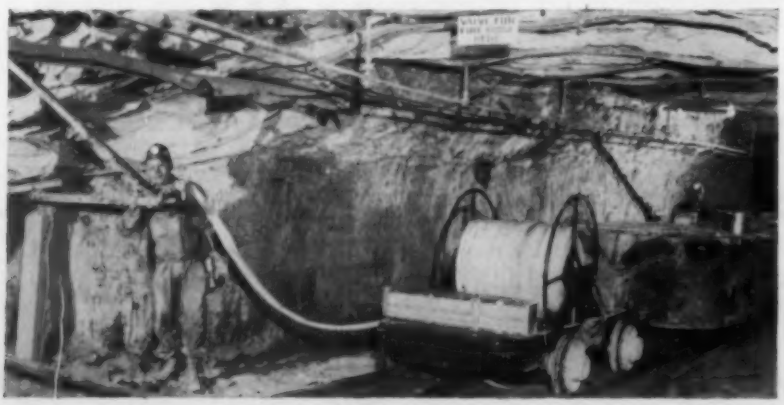
Mine Explosions—How they happened, with recommendations to prevent recurrences. *Coal Age*, May, 1957, p 96, and April, 1958, p 30.

Fire Control—Equipment, organization and training are the elements required for effective fire fighting. *Coal Age*, July, 1957, p 66.

DESIGNING EQUIPMENT with the safety and convenience of the operator in mind has been highly successful in reducing injuries. Armored locomotive cabs, like this one, and automatic couplers have been helpful in reducing haulage accidents.



PROTECTION against fires, especially at large mines, may include fire trucks which are maintained in a state of readiness. Emergency supplies should be stored in protected caches which are inspected and inventoried at regular intervals.



WHERE AMPLE WATER is available under pressure, self-contained fire trucks may be replaced by hose trucks. Locations of "hydrants" should be carefully planned and well marked. One company provides for reversal of flow from main pumps to provide fire-fighting water in working sections.

for handling each function, and this is another top-management exercise in bringing together the skills available within the official family and the jobs to be done. The staff of the company safety department should be neither too large nor too small. An overweighted safety department may become a "dumping ground" for a number of other activities for which a natural home cannot be found in other company departments. The result is a loss of enthusiasm for safety and these losses are doubly difficult to make up.

The understaffed safety department, on the other hand, may miss too many good bets in safety because of difficulty in maintaining proper coverage of its legitimate responsibilities. The best way to get the proper manpower, in quantity and quality, is through sincere top-management consideration of the matter. A top-notch safety department is worth the effort because it pays off in better employee and public relations, reduced labor turnover and increased efficiency, in addition to its primary function of accident prevention.

EMPLOYEE PARTICIPATING—Employee safety committees should be included in the table of organization. Their recommendations concerning hazards should be heeded and acted upon, their suggestions should be carefully weighed, and their active support in training and promotion ventures should be solicited at the beginning of such ventures.

An excellent example of how such cooperation pays off appears in *Coal Age*, March, 1957, beginning on p 64. The result was that a large mine was able to complete a full year without having a lost-time injury or fatality caused by roof falls.

JOINT ACTION—Above the company level a need may exist for an organization to promote safety for a group of mines or companies having similar safety problems. A full description of an organization of this type appears in the September, 1955, issue of *Coal Age*, beginning on p 58 and featuring the highly successful operations of the Indiana Joint Committee for Coal Mine Safety. This is a truly cooperative effort.

Wholehearted support of local safety associations and institutes by the company and participation of company safety officials in the affairs of Holmes councils and chapters, the National Mine Rescue Association and National Safety Council, for example, are proper extensions of top-management's interest in safety. These, too, represent organizations for safety. Of course, cooperation with federal and state safety and inspection authorities is an integral part of any safety effort.

Training and Education

THE TERMS training and education are not synonymous. They are two distinct functions, differing in scope and in emphasis. Safety education is a broad program designed to convince workmen and supervisors of the waste inherent in a high accident rate, and of the real values in high safety performance. Safety training, on the other hand, usually takes the form of a hard-hitting, direct attack on particular hazards, like 100% training in accident prevention. Safety education is a continuous process, while safety training, on any particular subject, begins, proceeds and concludes in a scheduled well-planned manner.

The educational mission can be carried out through the use of a company publication (if thoughtfully prepared), a well-planned poster campaign, word-of-mouth advice and management example. The safety display board near the lamphouse or at the entrance to the property can be a big help here. If it can't be kept timely, however, and if it isn't kept reasonably clean and in good repair, it might better be removed from sight.

TRAINING FUNDAMENTALS—A need for training may be indicated by a general rise in frequency or severity rates. Or the number of injuries chargeable to a single cause—haulage, for example—may spurt upward. Next step is to select the training material, basing the selection upon the recognized needs of those to be trained. If an outside agency is to conduct the training, these instructors and company representatives should meet to examine the content of the course to make certain it fills local needs.

Course material should be severely limited to the interests and needs of the trainees. In a course for cleaning-plant personnel, very little reference need be made to the fact that roof falls and haulage are the major causes of accidents in the industry. They are more concerned with safety on stairs and ladders, and with such other matters as falls of person, open machinery, dust hazards and electric shock.

PROMOTING ATTENDANCE—The problem of getting men to attend the training sessions can be a tough one. The safety committee can be of great help here, if the committee has been consulted early in the planning stages. In striving for 100% attendance at accident-prevention training sessions, conducted by Bureau of Mines instructors, company officials will achieve maximum results by working closely with district officials.

Beyond this basic training area there is advanced training work any company may profitably pursue. Periodic training in advanced first aid and mine rescue may be offered to selected men and supervisors. One important goal of this training should be the development of new instructors.

Training, though, is not an end in itself. The clincher is in management's follow-through, which insures that results match the effort.

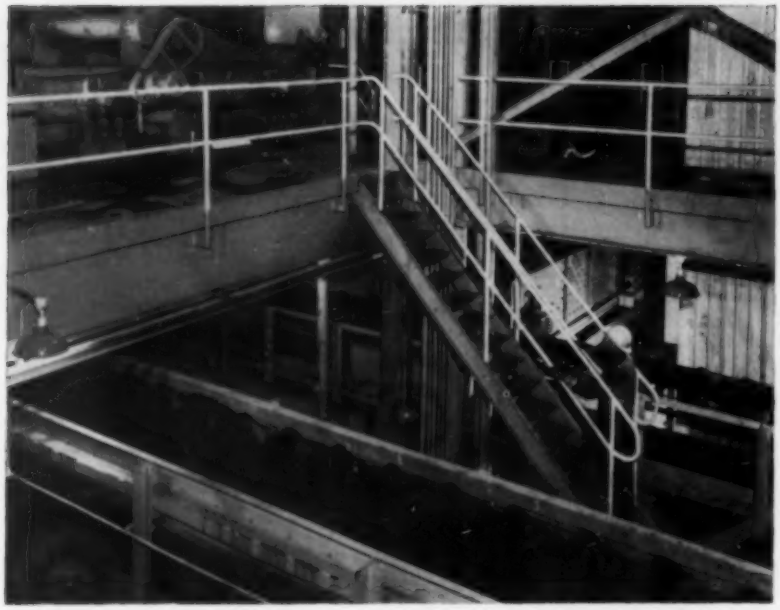
Plant Maintenance Serves Safety

VIGILANCE is the keyword in maintaining a mine, cleaning plant or strip pit in safe condition. A sluggish track switch in the mine, "soft" brakes on a strip-mine haulage truck, dust accumulations in the preparation plant—all these are examples of potential accidents that can be headed off by good plant maintenance. In this connection, the plant includes all real estate, above and below, and equipment.

The steps through which this safety maintenance is achieved are the old standbys—inspection, reporting, repairing and following through. It is to be noted here that all technical and operating departments have a safety function, inasmuch as each is responsible for some degree of inspection and repairing within its own area.

Some larger companies, employing full-time safety inspectors, have set up hard-and-fast rules on clearing up hazardous conditions. The company safety inspector at the end of his visit leaves at the mine or plant a list of the hazards and violations of good practice he has found. Copies of this list are filed in the safety department and with the operations chief. Mine officials are required to take appropriate action to remedy the condition, then report their actions through proper channels to the chief of operations. If such a report does not come up within a specified time, the safety department and chief of operations begin to ask questions. The system insures follow-through on safety-department recommendations.

DEEP MINES—The most important elements in maintaining a deep mine in safe condition are roof support, methane control and dust suppression. Falls of roof, rib and face still are the No. 1 killer, although a striking improvement under bolted roof is now in the records. The most promising remedies are closer



SAFETY of personnel should be a major provision of surface-plant design.

supervision, strict compliance with timbering standards and bolting patterns, including as much extra support beyond the standard pattern as necessary, and better trimming of overhanging brows and loose coal. These are the only possible solutions to the problem as long as men are needed at the face.

A new development, for increased safety in the immediate face area, is a self-advancing roof shield which may be powered from the hydraulic circuits of a continuous miner. The unit was unveiled at the recent AMC Coal Show.

Efficient ventilation is safe ventilation. Proper methane control demands that sufficient air at reasonable velocity be moved past active faces to dilute and sweep away the gases issuing from the coal. Maintenance of physical plant in the interest of safety demands that bleeders, if they are part of the mining plan, be kept open, that stoppings be sealed against leakage and that airway obstructions be removed. Effective gas detectors also must be considered as safety maintenance tools.

In underground dust suppression the big guns are rock dust and water sprays. The latter may include wetting agents. Recent developments in rock-dusting machinery now permit in-cycle distribution.

Wet rock dusting is the latest application method. Goals are not only a good dusting job but also elimination of the dust problem, which can be particularly acute in dusting in cycle behind a continuous miner. Methods and equipment in two mines are outlined in articles in the following issues: *Coal Age*, February, 1955, p 82; January, 1956, p 62. Now in use is a slurry-type rockduster which can be mounted directly on mining machines, and a self-propelled unit.

Whatever the methods, however, the main point is that the rock dust should be evenly distributed, in back headings and returns as well as in more active places. Rock-dust barriers may be included in the overall plan, and the importance of loading out excessive accumulations of coal dust should not be overlooked.

Knocking dust down as it is made by water sprays takes on added importance not only as a means of reducing the explosion hazard but also because of the increased disposition on the part of compensation commissions to grant awards for purported lung damage, even though coal dust still is to be proven as the culprit. For the latest on the question of coal's possible role in lung trouble, see the July, 1958, issue of *Coal Age*, p 56. In any event, prudent management will do its best to keep dust counts below the accepted minimum and supply dust masks when working in high concentrations cannot be avoided.

In all instances, maintenance of a safe plant requires the establishment of fire-fighting systems, including water lines, tested firehoses and chemical extinguishers, where needed. First-aid supplies should be provided in clean, well-lighted rooms.

STRIPPING—In stripping, safety maintenance is primarily a matter of equipment maintenance. A schedule for wirerope changes should be worked out, since each unexpected rope failure is a potential accident. Haulage trucks must be kept in good conditions to head off steering and brake failures particularly. Well-drained smooth-surfaced roads may eliminate dangerous skids, and in dry weather road surfaces should be sprinkled.

Truck spotters must be properly trained to stay out of the way of backing trucks and out of close clearances around dump ramps. They should also be competent in keeping drivers out of trouble.

PREPARATION — In preparation plants, particular check points for safety inspectors are dust accumulations on beams, housekeeping in the oil-storage area, cleanup precautions before any welding is done, open gearing, exposed wiring, overhead obstructions and so on.

The possibility of using paints of different colors in the plant might be weighed. For example, standard colors for safety include red for fire exit signs and fire equipment; orange on the inside of movable machinery guards and exposed edges of pulleys, gears, rollers and so on; yellow for handrails, top and bottom steps and caution signs; green for first-aid equipment; and black and white for traffic lanes and direction signs.

One final requirement, if all this maintenance is to be meaningful, is that workmen wear proper articles of protective clothing and refrain from wearing loose clothing.

Keeping Interest Alive

ILL-ADVISED INCENTIVES may not set back the cause of safety but they can be a waste of time for the safety department. A decision to adopt or reject a proposed incentive must be based upon thorough study, with local conditions and personalities weighing heavily in the final judging.

Strange as it may seem, safety bonuses for supervisors have not been an unqualified success in all quarters. The privilege of wearing a white safety hat for supervising a crew through an accident-free month may be more exciting. And even more worthwhile is some scheme where everyone participates in making a good record and shares in the acclaim.

Slogan contests are effective attention getters, if properly conducted. Application blanks may be distributed as payroll inserts. The response will be gratifying if the prize is worthwhile. Then interest and participation in the next contest will be assured if the winning slogan is widely promoted.

Once an incentive has been adopted it must be given a fair chance to succeed. But if it still fails to have the desired effect in creating enthusiasm or reducing injury rates, it must be summarily dis-

COMPANY PHOTOGRAPHER and safety director (left photo) prepare to go underground to reconstruct a recent accident. At right is a photo of the reconstructed incident which will be published in employee publication and displayed on bulletin boards.

TRANSPORTATION ACCIDENTS are reenacted for the photographer. This new approach to safety promotion has resulted in a significant decrease in frequency and severity rates at one large company through better communication of the safety message to employees. Photographs can also be used to illustrate authentic "Do's" and "Don'ts" with respect to work habits.

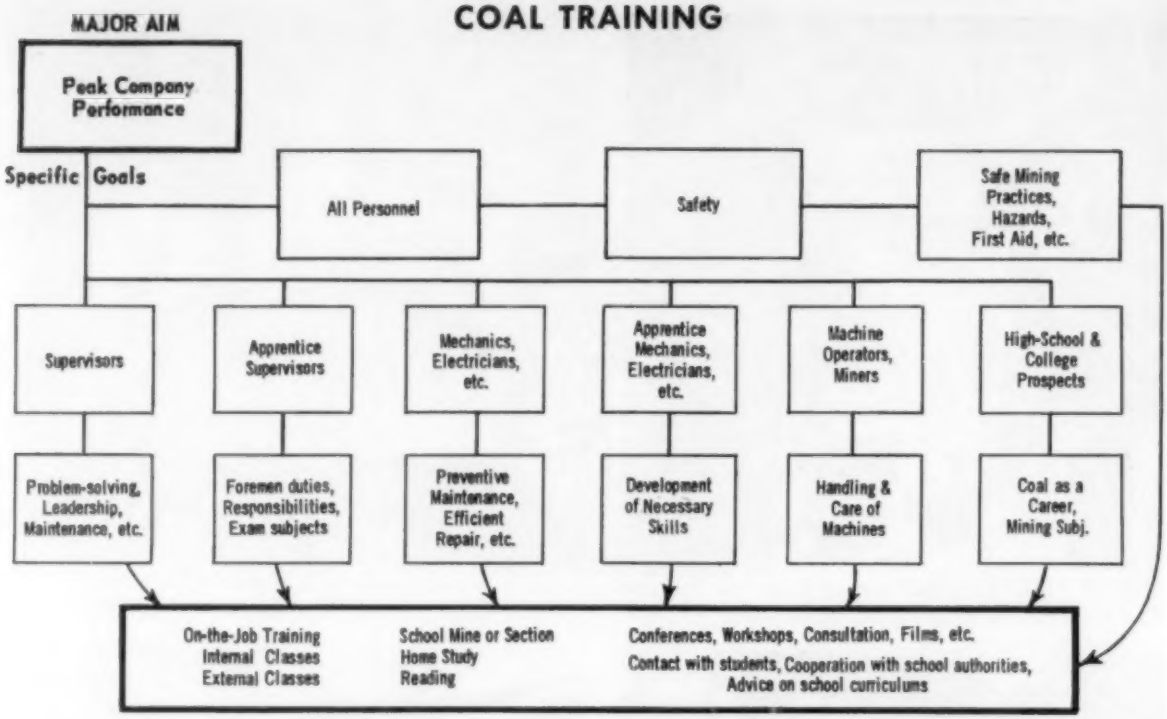
In safety promotion—a picture is worth 1,000 words

carded. Permitting such an incentive to drag on with only half-hearted promotion may be mighty damaging to the entire safety program. Best practice in a situation like this is to have another idea ready to take the place of the incentive you must scrap, although the new idea should be one that has a better-than-even chance of success.

FOLLOW-UP TRAINING—Timely scheduling of refresher training sessions is another way of keeping safety interest at a high level. The accident-prevention training offered by the Bureau of Mines is practically a "must" at all mines because it has captured the interest of the men at mines where it has been given already. Follow-up sessions on this type of training are especially recommended to insure that maximum longtime benefits accrue.

One of the best ways to keep the safety program alive is to look for opportunities to reward individual achievements in safety. The recipients will be happy to have their achievements recognized, and the others will have their interest aroused. Notable individual safety records can be searched out at virtually every mine.

Recent reports from several sectors point up the opportunities to which management should be alert. In one instance, a unit foreman led his crew to the safety of a barricaded position following a disastrous explosion. All were rescued after several hours. In another case, a workman was lowered in a makeshift cage to the bottom of a blast-damaged shaft as the exploratory first step in a recent recovery operation. Subsequent work was based on his exploration. These men were properly honored. Such achievement should not be overlooked. On the other hand, day-by-day attention to safety which results in a commendable record of accident-free performance should be recognized. The cause of safety will be better served if this recognition is forthcoming.



Training: Vital to Progress

How to Train

How miners and management personnel are trained depends generally on company training philosophy, the number to be trained, the type of training and who is to be trained. Those methods generally employed, or most desirable, for training miners include the following:

1. On-the-job mine or shop training. At least some exposure to this type of training is virtually indispensible for apprentice supervisors, apprentice mechanics and electricians, and machine operators.

2. Classroom instruction and extension courses. Where only one, two or a few men are involved, the mining school extension course is frequently the best expedient.

3. Combined classroom instruction and on-the-job training. Some companies find that textbook learning must be accompanied with practical experience for best results.

4. A school mine or section serving a field or a group of company mines. This method is specially good for training new employees, transfers, etc.

For training supervisors and managers, the following techniques are considered good practice:

1. Regular conferences and meetings, including reports from standing or special committees. Free discussion of problems and other matters of mutual interest open the way to increasing the individual supervisor's or manager's knowledge and skill.

2. Formal instruction courses. These may be presented in strictly textbook and/or discussion form, or can be accompanied by laboratory work as, for example, the study of controller panels, etc.

3. Home study and reading. Keeping abreast of current developments in the industry and of good mining practices as, for example, through regular reading of *Coal Age*, is an avenue of learning dependent only on the individual's initiative.

Who to Train

In evaluating training needs, a company can consider giving the following types of instruction to the following groups:

1. All company personnel—General safety training. This can help greatly to increase individual safety consciousness and to promote safe mining practices. Certain personnel, furthermore, might receive specialized instruction to suit occupational needs. The underground man, for example, has the greatest need for detailed information on the dangers of inadequate roof support. Similarly, the tippleman needs special coaching on the hazards of preparation plant machinery and equipment.

2. Mechanics and electricians—In-

Where to Find It..

How to Train ..... p 342
On-the-job . . . Classroom . . . School mines . . . Meetings . . . Home study

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All personnel . . . Mechanics and electricians . . . Machine operators . . . Apprentices . . . Supervisors and managers

Training Foremen ..... p 343
Developing new foremen . . . Upgrading the experienced

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The existing force . . . New staff . . . Supervisors

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On-the-job . . . Manufacturers' instruction . . . Surface course . . . School mines

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Getting cooperation . . . General practices

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Engineers . . . Mine force . . . A high-school program

struction in preventive maintenance procedures, how to spot equipment troubles quickly, and how to make repairs efficiently.

3. Machine operators and selected alternates—Training in how to handle and care for their machines to ensure maximum performance in the production cycle.

4. Apprentice supervisors—Instruction in the foreman's duties and responsibilities, and in all mining subjects he must know how to certify for foreman's papers. Trainees should be carefully selected for leadership qualities.

5. Apprentice mechanics, electricians and shop workers—Training in the reconditioning and rebuilding of equipment. Recruits can be drawn from company ranks or from outside sources.

6. Supervisors and managers—General instruction in how to be better bosses, and special instruction in how to increase their knowledge and skills in certain areas of responsibility. Foremen well trained in spotting equipment troubles and in good preventive maintenance, for example, can contribute much to minimizing downtime.

Training Foremen

The training of foremen usually breaks down into two main parts: training experienced foremen to do a better job, and training men from the ranks on the foreman's duties and responsibilities.

DEVELOPING NEW FOREMEN—"Imports" of good foremen are becoming scarcer and, furthermore, experience shows that this method is not a reliable means for procuring topnotch career men. Perhaps the best bet for adding to the supply of quality foremen is by upgrading men from the ranks through a combined process of classroom instruction and on-the-job training.

A number of variations of this technique may be employed, especially as these variations deal with the relative amount of time devoted to classroom work and to on-the-job training. One company figures on a 3-mo course which dovetails 600 hr of on-the-job visual education with 75 hr of textbook learning, discussion and home study.

By rotating foremen trainees for 2-wk stretches of on-the-job training in six different mines over a 3-mo period, each man is able to (1) gain first-hand knowledge of a wide variety of seam conditions and mining systems and (2) observe 30 to 40 different foremen on duty. In this way trainees can see for themselves what makes a really good foreman tick. Comparisons are readily made, for example, as to which foremen get the best response from their men and which take the most pains in good housekeeping. Perhaps most important, trainees note:

1. That the mine or section foreman is the key to high productivity.
2. That the foreman's attitude—whether aggressive or lackadaisical—is reflected throughout the ranks of his men.
3. That many mining problems stem from lack of understanding between the foreman and his men.
4. That a good foreman must be able not only to handle men but also to get along with them.
5. That to be successful, a foreman must be a true leader—not only well-informed on the art of mining, but also well-versed in the limits of his authority, and well-practiced in how to be fair and when to be firm to all his men.

On-the-job training should be supplemented with at least 1 hr of classroom instruction per day. It may be necessary to set up two classes to accommodate both day and night shifts. Instruction, given by company or outside experts, or both, should cover all subjects basic to foreman certification. A full curriculum, for example, might include ventilation, gases, approvals and permits, records, general mining practices, explosives, belts and conveyors, electricity, first aid, roof-bolting, general safety, lamp assembly, gas testing and anemometer use. Specal instruction on the supervisor's duties, on company standards, and on the importance of human relations in job performance is highly desirable.

Textbook instruction can be based on the state mine foreman's guide (if one

Why It Is Vital

Overall goal of training is to achieve peak performance of the total operating force—both management and men. Peak company performance is vital to getting maximum returns from higher investments in manpower and equipment, and, in turn, to keeping costs down and holding market advantages over competitive fuels.

Training is also vital to developing a greater supply of skilled talent for tomorrow's higher tonnage output. Predicted shifts in the makeup of the operating force show that a major drop in the number of production men will be accompanied by an equivalent increase in the total of certain highly skilled categories—supervisors, engineers, and maintenance, general-inside and preparation men.

Starting a Program

Check over the entire production force to determine what types of training are needed.

Consider the value of training for both specific and general occupational needs.

Success Keys

1. Define the objectives of training and make these publicly known to the maximum number of eligible participants.
2. Conduct a careful screening of candidates for new jobs and higher-ranking jobs. Screening techniques include personal interviews, application forms, personal references, aptitude tests, etc.
3. Organize and outline the training, using instructors who are not only well-versed in their subjects but also capable in the art of communication.
4. Provide adequate, comfortable facilities for classroom instruction, where included in a training program, as well as authoritative textbook material and illustrative training aids.
5. Create a training environment that will encourage employee participation. Salaries for working personnel, for example, should not suffer; transportation problems should be worked out.
6. Arrange for periodic follow-up of trainee performance on the job and make refresher courses available to those who want to brush up.

Field Reports

Testing Personnel—Psychological tests have proved practical in measuring employee ability and personality. Correctly used, they can be a real asset in upgrading personnel selection and placement. *Coal Age*, September, 1957, p 70.

Recruiting Youth—Industry, schools and parents in the Bluefield (W. Va.) area cooperate to whet youthful appetites for careers in engineering and vocational trades. Program activities are directed toward public relations, science fairs, engineer speakers, guidance, and school problems. *Coal Age*, November, 1957, p 54.

Troubleshooting—Classroom and laboratory training aim to develop competent men in electric troubleshooting and maintenance. A basic course covers electrical circuits, contactors and relays, DC motors, and wiring diagrams. Qualified men move to advanced training in hydraulics. *Coal Age*, December, 1957, p 72.

Shop Training—An 18-mo shop training program for new recruits provides a reserve of potential maintenance men. Interest of older workers is increased through a 60-hr course in basic electricity. The payoff: Less downtime. *Coal Age*, January, 1958, p 110.

Mine Maintenance—The Winding Gulf Operators Association and the Raleigh County Vocational School, Beckley, W. Va., cooperate on a training program to educate field maintenance men. The aims are to relieve the area's personnel shortage and build up a reserve of skilled electricians, mechanics and shop men for the future. *Coal Age*, December, 1958, p 90.

Management Workshops—Penn State Mineral Industries Extension Services pioneer in a series of five-day workshops planned exclusively for coal. Programs are beamed to all levels of management, from foreman to president. No geographical limits are placed on participating companies. *Coal Age*, June, 1959, p 76.

is available), or on publications of state mining departments and extension services of mining schools. Such material is usually most effective if adapted and simplified by company instructors.

UPGRADING EXPERIENCED FOREMEN—Foremen on the job can get valuable training through conference discussion of their problems with other foremen and with superintendents. The conference method brings collective experience to bear on current problems and permits valuable exchange of know-how and ideas.

One of the best ways of implementing this technique is through regular meetings at the mines. Foremen meet with their superintendent in his office, or some other suitable place, for 1 or 2 hr. The meetings can be arranged so that each foreman from each shift manages to attend one conference of every two or three.

At these sessions, the freest possible discussion is encouraged—no holds are barred. In this way, many opportunities are provided for practical schooling not only in operating and labor questions but in mine mathematics, physics and chemistry. Sometimes, foremen are asked to prepare a "laundry list" which promotes discussion on such problems as:

1. How to instill the spirit of cooperation among employees.
2. How to eliminate absenteeism.
3. How to minimize carelessness and "goldbricking."
4. How to recognize desirable characteristics in a satisfactory foreman.

The conference method also finds expression through division- or company-wide meetings. Foremen are taken off the job for 5-day periods and meet in some central geographical spot to participate in an organized conference agenda. Here, the aims are usually broader in scope than at mine meetings. Company activities and policies are discussed and practical help is given in leadership, employee and community relations, efficient conduct of safety, maintenance, production work and product control. An opportunity is provided to meet and get acquainted with top company officials. The program also includes relaxation and entertainment.

For formal instruction to foremen, consider the possibility of giving night classes from September to May. Classes might meet two nights a week from 8 to 10 PM. Subjects covered could include mine engineering and mathematics, public speaking, better reports, techniques of job instruction and conference leadership.

Men from these classes might then be selected for an intensive 2-wk summer course, meeting 6 days a week from 8:30 AM to 4 PM. Successive groups could be selected between June and early September. While they are going to school, foremen should be paid their regular salaries and no charge should be made against vacation time.

Maintenance Training

IMPROVING THE EXISTING FORCE — Modern practice points to in-company training, based on combined classroom instruction and practical experience, as the best way to upgrade the quality of the existing maintenance staff.

One company, for example, sets up a definite course of instruction, on company time, for an initial group of 18 mechanics in three classes of six men each (*Coal Age*, April, 1957, p 76). Each of the three classes meets twice a week from 8 AM to 11 AM, in a specially equipped classroom near the surface shop. The course is designed to provide a minimum of 48 hr of instruction and practical exercises in electrical theory and trouble-shooting. Before the program is completed, 36 other mechanics have an opportunity to take the training.

Purpose of the training program is to provide means through which the men presently employed as section and shop mechanics can upgrade themselves to handle the problems of modern machine mining more efficiently. In developing this program, management was inspired by these two facts:

1. Good preventive maintenance and the fastest-possible location and clearance of electrical troubles are absolute necessities.
2. No one can criticize the work of a mechanic if he is not equipped with the proper tools and the training he needs to adequately maintain today's mining machines.

With such considerations in mind, operating officials and maintenance men met to discuss ways and means of improving maintenance. The outgrowth of these meetings was a formal instruction program, sponsored by the extension services of one of the leading university mining schools.

Instruction begins with a review of the fundamentals of electricity, including the relationships in Ohm's law, characteristics of series and parallel circuits, and the proper use of meters and instruments. Basic principles of motor operation and the functions of relays and contactors are thoroughly treated, using

actual machine components as instructional aids.

The aim of this instruction in fundamentals is to draw together on common ground the six men in each class, who most likely have diverse aptitudes and experience. From this point, the emphasis is on trouble-shooting.

Several concessions are made by the company, and by other mechanics not yet in training. The company agrees to have the men attend the school two days a week for the specified hours and then to complete these shifts on their assigned jobs. This means that, while men are enrolled in the course they must work steady dayshift during the instruction period. The other mechanics, who enter training later, rotate on the second and third shifts to make this schedule possible.

Benefits of the program indicate that maintenance will be improved through increased job knowledge and job interest among the maintenance men. Reductions in downtime, resulting from faster clearance of outages, are expected to return the investment in training within a reasonable period of time. And a valuable by-product of the training may be the discovery of unrealized leadership talent among the maintenance men.

RECRUITING NEW STAFF—More frequently than not, the announcement of shop training for apprentices brings a deluge of applications, considerably in excess of job quota needs. Thus, one of the biggest jobs in adding new maintenance men is in the selection of trainees.

Initial screening is usually based on personal interviews with operating and maintenance officials. For further screening, aptitude tests may be employed to determine more scientifically a candidate's intelligence, knowledge and fitness for mechanical or electrical work.

In one 18-mo shop training program, trainees are put to work in the central shop, primarily on the rebuilding and reconditioning of equipment. They work with experienced mechanics and electricians, covering all phases of maintenance work, from the dismantling of equipment to final assembly and testing.

Along with practical shop work, lecture and classroom study is provided. This part of the training program is conducted in a central repair shop classroom which is equipped with a lecture and demonstration table, a large blackboard, and an opaque projector and screen. Through the use of these facilities, the basic fundamentals of lubrication, hydraulics, mechanics and electricity are explained and illustrated. A special effort is made to have the lecture material coincide with shop work. To round off the program, representatives of various manufacturing companies give lectures on the construction and care of machines and equipment.

A shop training program of 18-mo duration naturally involves a great deal of instruction time. This may become quite a problem as the need increases for adding more new mechanics, electricians, etc., to the staff. One solution here is to start new trainees on a staggered system so that older trainees can assist newer ones.

SUPERVISOR TRAINING—Substantial savings in production time and maintenance costs can be achieved if foremen have a better appreciation of the care of mining equipment. Such appreciation can be best achieved by showing them how to spot equipment trouble before a major breakdown occurs. A company should expect foremen to take instruction as an opportunity to learn and become more valuable employees.

A typical course might include instruction in the fundamentals of electricity. Such topics could be covered as Ohm's law, wiring and magnetism, AC and DC principles, DC mine circuits and Lenz's law. With this as a foundation, foreman students could pass to applied maintenance procedures—for example, how to read schematic wiring diagrams, and how to trace and isolate trouble in one part of a circuit and then check items in that section.

The benefits of foremen's maintenance training are not always measurable in dollars and cents. They are reflected in other ways. There is better cooperation between foremen and mechanics. Major breakdowns are prevented since equipment is stopped and repaired before it fails completely. When a failure does take place, there is less downtime because the foreman and mechanic work with the wiring diagram and all effort is directed to fixing the machine rather than to "shooting in the dark." A frequent result is that fewer new parts have to be purchased. Although not easily measurable, benefits add up to more production per shift.

Training Machine Operators

Miners require a great deal of skill to get top performance from modern coal-mining machines. Thus, adequate training in the handling of continuous miners, shuttle cars, cutting, loading and drilling machines, timbering and roof-bolting machines, etc., becomes a key factor in achieving maximum mine output. Through the proper handling of machines, the operator also plays an important part in preventing abnormal wear and tear which lead to breakdowns and lost production time.

In most cases, machine operators learn their jobs through on-the-job training as helpers to experienced men. Some of the largest machine manufacturers conduct instruction programs on machine operation for customers. Where such training is available, companies should take advantage of it, especially when shifting from conventional to continuous mining machines.

At least one company has found it beneficial to train shuttle-car and cutting-machine operators above ground. A surface course is staked out and chalk-lined to duplicate the turns an operator must make underground. Trainees then practice for 6 or 8 hr periods under the supervision of the mine superintendent or safety director. As a result, machine maneuvering skills are improved and fewer timbers are knocked out.

SCHOOL MINES—A small training mine or section—serving a field or a group of company mines—is an excellent way to provide practical schooling in machinery operation.

This technique would be particularly helpful in training new employees, transfers, etc. It also may help to cut down the cost of training. Coal produced in the training mine can be marketed, like any other coal, through the sponsoring company or association. With an experienced foreman and one or two experienced assistants, the cost of such coal might not be too much higher than coal from a regular working section. And once on their regular assignments their production and safety performance should result in lowest cost.

Safety Training

Better mine engineering will continue as a basic attack in the industry's battle to reduce accidents and fatalities. Equally important, however, is attack on the most stubborn of all obstacles—the foibles of human nature. When every individual realizes more completely his safety responsibilities to himself and his co-workers the stalemate, in all probability, will break. And better individual understanding means primarily one thing: more intensive and extensive safety training and education.

Basic to safety training are the following guideposts:

1. **Safety training** should be given to all personnel, from the manager in the office right down the line to the man at the face.

2. **Unrelenting effort** should be made by all personnel to observe safe mining practices and to comply with safety laws and regulations.

3. **Good housekeeping** should be practiced at all times—carelessness and messiness are the harbingers of accidents.

4. Thorough training should be provided in the proper handling of machinery, equipment and tools.

5. All personnel should be thoroughly indoctrinated in the actual and potential hazards of their occupations, and properly equipped with safety gear when necessary.

6. Horseplay and taking chances should be outlawed.

7. More emphasis should be placed on getting cooperation in good safety practice than on inflicting penalties for breach of good practice.

It is difficult to document what individual companies should do to carry out a vigorous campaign of safety training and education since, in each case, methods should be suited to particular needs. But a number of general practices have evolved which have proven their worth, or have received fairly widespread acceptance. These include:

1. **Setting up a committee** to promote the cause of observing safety laws and regulations and to act as liaison between management and labor on grievances.

2. **Posting bulletins, cartoons and other billboard data** at strategic points to arouse safety consciousness on the job.

3. **Instructing foremen to organize weekly meetings** between themselves and their crews for the discussion of current safety problems.

4. **Arranging for USBM instructors to** give their 100% accident prevention training course to all personnel.

5. **Providing instruction** in first-aid and mine-rescue work.

6. **Participating** in safety contests.

7. **Promoting attendance at Holmes** safety chapter meetings.

Recruiting Youths

Essentially, selling the coal profession to young men involves improving and expanding existing pre-employment and training programs.

Excellent publicity material has been prepared for all levels of students by the National Coal Association, other coal associations and some companies. Mailings of such material, however, are dwarfed in comparison to educational programs carried on by other industries.

One of the most promising developments on the recruitment scene is increasing management recognition of the importance of interesting high-school students in coal-mining careers. More and more personnel managers are realizing that the high-school student, particularly in coal mining areas, is the key to long-range fulfillment of personnel needs. However, although a handful of companies are conducting aggressive high school campaigns, only the surface of opportunity has been scratched.

ENGINEERING RECRUITMENT – Some 200 scholarships in mining engineering are offered throughout the country by coal associations and individual companies. But this number is certainly not adequate when compared to the industry's immediate needs for engineers mentioned above. It becomes even less adequate in view of reports that many existing scholarships go unclaimed.

Much could be done to alleviate the scholarship situation by more widespread advertising of scholarships, by sending company and association representatives to recruiting areas to sell the modern coal profession to prospects, and by setting up salary scales and living conditions commensurate with standards in most other professions and industries.

When scholarships are awarded for college study, it is frequently desirable to pin the grantee down to a formal contract. By this contract, the company agrees to pay, say, $1,000 per yr for 4 yr of college education. In return, the grantee agrees to work for the sponsoring company for at least 2 yr after graduation.

Salaries offered sometimes can not be as good as those offered by some other industries. But the differential, where occurring, is made up through the benefits of the 4-yr scholarship. Also, by having the grantee agree to work for at least 2 yr with the company, he is brought to the point where he can take the mine foreman's exam, thus qualifying for higher pay. At least one company has had outstanding success in holding grantees by this system.

MINE RECRUITMENT – Engineers are one industry need, but miners, mechanics, electricians and bosses are equally critical now and in the future. A well-thought-out and well-carried-out program also serves to build the interest which will make recruitment in these categories more rewarding among high-school and junior high-school students.

There are a number of approaches to developing and holding the interest of such students. A typical approach, however, might capture the interest of boys and their parents in the modern coal mining profession through sponsoring science fairs, movies and lectures about coal, and inspection trips to mines. These efforts might be accompanied by offering aid to organize high school mining curricula and to set up vocational guidance committees. It might also prove expedient to subsidize, or otherwise provide, necessary teaching and guidance talent.

High-school mining courses are generally designed for 3 yr and school time is divided between traditional academic subjects and vocational subjects, with careful correlation to insure that boys will become good citizens as well as good miners. A typical course might be made up as follows:

Sophomore Year, Mining Subjects—Geology of coal, mine law, mine gases, ventilation, timbering. **Shop work**—Welding, bench work, lathe, drill, shaper.

Junior Year, Mining Subjects—Tracks and transportation, ventilation, drainage, pumps and pumping, related mathematics. **Shop Work**—Electrical circuits and diagrams, motors and controls, resistances, testing equipment.

Senior Year, Mining Subjects—Explosives and blasting, ventilation, mine law, mapping and drawing, mine chemistry, applied trigonometry. **Shop work**—Hydraulics, general mechanics (clutch, transmission, gears, power), timbering, tracklaying.

All Three Years—Academic Subjects: English, social studies, physical education.

Teachers forming courses like the above are, for the most part, experienced coal mining men. Realizing that teachers with coal mining experience are essential but scarce, coal operators and associations can cooperate to seek out properly qualified men for teaching jobs.

Help in Buying . . .

A COMPLETE CROSS SECTION of the modern equipment, materials and services offered by manufacturers and service organizations is presented in this issue to round out this *Coal Age* Mining Guidebook.

See P 351

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

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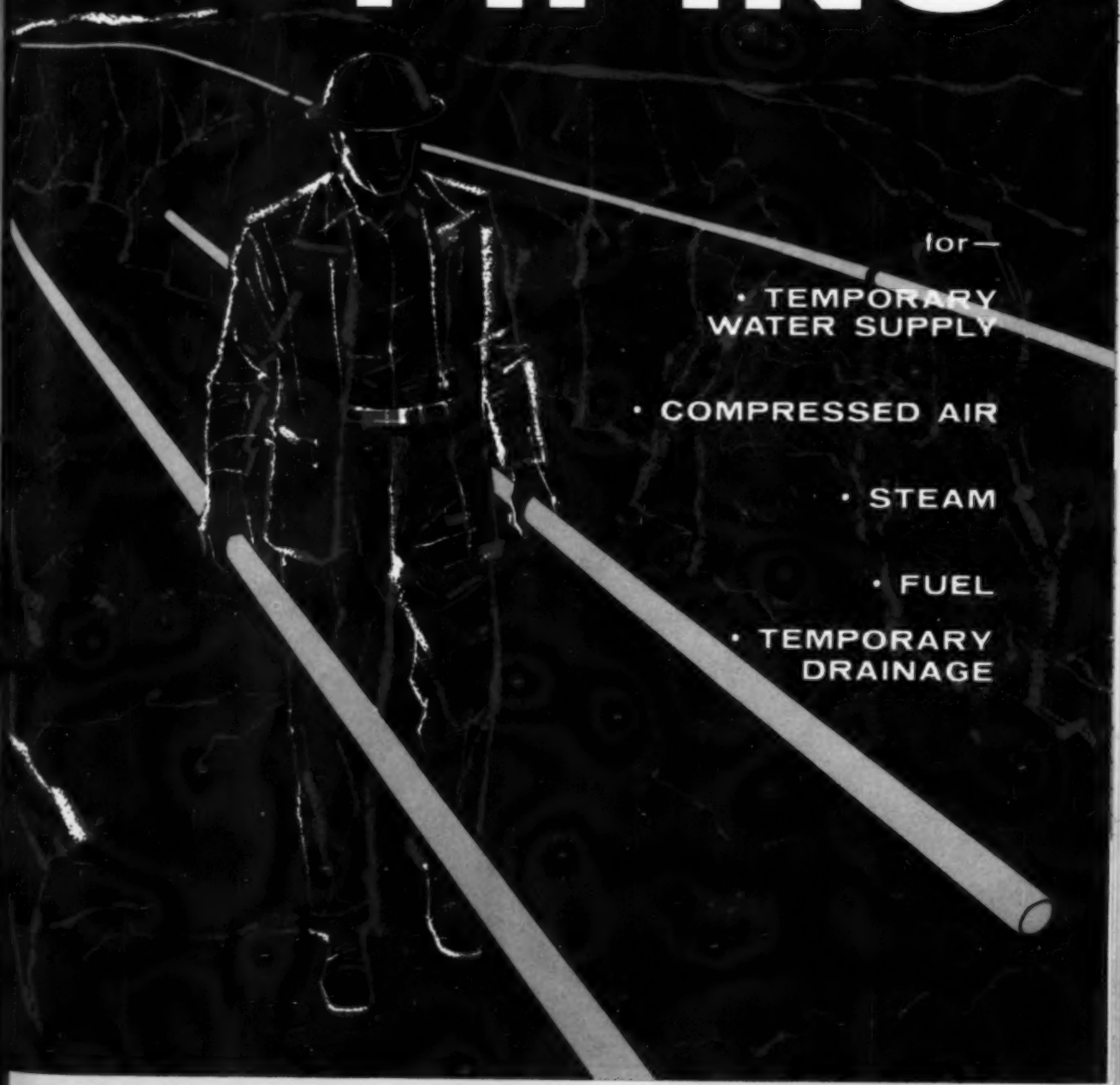
COAL FIELD AND CONSTRUCTION

PIPING



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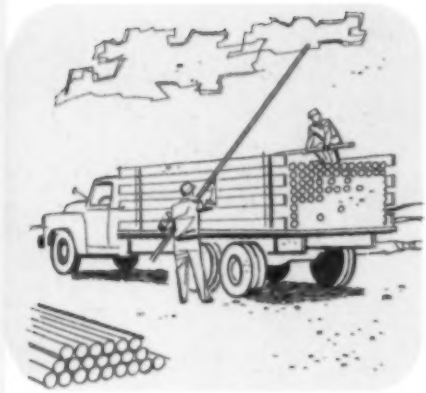
- TEMPORARY WATER SUPPLY
- COMPRESSED AIR
- STEAM
- FUEL
- TEMPORARY DRAINAGE

ALCOA ALUMINUM PIPE PERMITS LOW LABOR AND HANDLING COSTS

. . . when lines must be installed or moved frequently

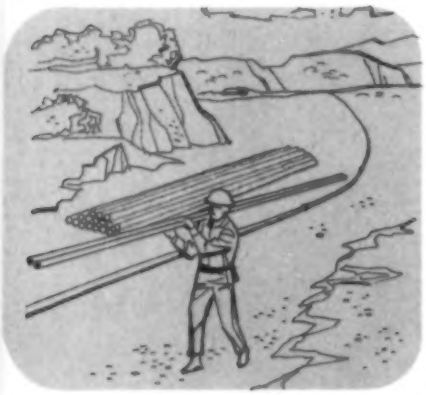


it's portable

Standard lengths of lightweight Alcoa aluminum pipe can be readily handled by one workman. Large quantities can be handled by small crews.

it's economical

The long service life of Alcoa aluminum pipe and the time saved in installation make it competitive with other piping on a cost-per-foot basis.



it's strong and durable

Alcoa aluminum pipe stands up under rough use. Lines can be strung on the ground or suspended from supports.

it's corrosion resistant

Aluminum is highly resistant to corrosion. Expert technical assistance is available through your nearby Alcoa sales office to help you solve your specific corrosion problems.

it's easily picked up and relaid

Because of its light weight and the quick couplers now available, Alcoa aluminum pipelines can readily be dismantled and relaid—with minimum labor—to keep up with moving construction or mining crews.

it's available

Pipe supply dealers nearly everywhere carry full stocks of Alcoa aluminum pipe. You can get pipe and couplers from one nearby source.

it's smooth

Aluminum pipe has about the same friction factor as smooth drawn tube of other metals, and consequently offers less loss of head than most conventional piping materials.

ALCOA ALUMINUM PIPE SIZES

FOR PORTABLE AND TEMPORARY LINES

6063-T6 ALLOY

SCHEDULE 5 PIPE

NOMINAL PIPE SIZE, INCHES	OUTSIDE DIAMETER, INCHES	WALL THICKNESS, INCHES	WEIGHT PER LINEAR FOOT, POUNDS	BURSTING PRESSURE, POUNDS PER SQUARE INCH*
1	1.315	0.065	0.300	3,160
1¼	1.660	0.065	0.383	2,480
1½	1.900	0.065	0.441	2,160
2	2.375	0.065	0.555	1,720
2½	2.875	0.083	0.856	1,810
3	3.500	0.083	1.048	1,480
3½	4.000	0.083	1.201	1,290
4	4.500	0.083	1.354	1,150
5	5.563	0.109	2.195	1,190
6	6.625	0.109	2.623	1,000

SCHEDULE 10 PIPE

NOMINAL PIPE SIZE, INCHES	OUTSIDE DIAMETER, INCHES	WALL THICKNESS, INCHES	WEIGHT PER LINEAR FOOT, POUNDS	BURSTING PRESSURE, POUNDS PER SQUARE INCH*
1	1.315	0.109	0.486	5,450
1¼	1.660	0.109	0.625	4,250
1½	1.900	0.109	0.721	3,690
2	2.375	0.109	0.913	2,920
2½	2.875	0.120	1.221	2,650
3	3.500	0.120	1.498	2,160
3½	4.000	0.120	1.720	1,880
4	4.500	0.120	1.942	1,670
5	5.563	0.134	2.686	1,470
6	6.625	0.134	3.214	1,230

	NOMINAL PIPE SIZE, INCHES	OUTSIDE DIAMETER, INCHES	WALL THICKNESS, INCHES	WEIGHT PER LINEAR FOOT, POUNDS	BURSTING PRESSURE, POUNDS PER SQUARE INCH*
STANDARD CONSTRUCTION PIPE	2	2.000	0.050	0.3602	1,560
	3	3.000	0.050	0.5449	1,040
	4	4.000	0.050	0.7297	770
	5	5.000	0.052	0.9506	640
	6	6.000	0.062	1.3600	640
	7	7.000	0.072	1.8430	640
	8	8.000	0.094	2.7450	730
HEAVY DUTY CONSTRUCTION PIPE	2	2.00	0.055	0.395	1,720
	3	3.00	0.065	0.705	1,350
	4	4.00	0.072	1.045	1,120
	6	6.00	0.083	1.814	860

* These internal pressures are based upon minimum properties at operating temperatures not exceeding 100° F and the nominal dimensions of the pipe with no allowance for the effects of fittings or end connections, using a modification of the formula given in the 1951 Pressure Piping Code, ASA B31.1:

$$P = K\frac{2\,St}{D - 0.8t}$$

Where S = 30,000 psi and K = 1.02 for 6063-T6. When using the above computed internal bursting pressures for design, a suitable factor of safety should be applied.

Quick-acting detachable aluminum couplers are available from several manufacturers for all the above sizes

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you can get it promptly when you need it

A nationwide distribution network supplies Alcoa aluminum pipe from stock. Supply companies are listed in the Yellow Pages of your phone book under the "Pipe" classification. The staffs at 64 Alcoa sales offices listed below will be glad to help you locate a convenient source of supply. Ask for Alcoa Aluminum Pipe and Fittings Booklet (AD197) which describes the full line of Alcoa aluminum pipe.

ALCOA'S 64 SALES OFFICES

ABERDEEN, S.D., 304 Western Union Building
AKRON 8, OHIO, 506 Akron Savings & Loan Building
ALBANY 7, N.Y., 90 State Street
ALLENTOWN, PA., 1132 Hamilton Street
ATLANTA 9, GA., 1615 Peachtree Street
BALTIMORE 1, MD., 400 Meyerhoff Building
BIRMINGHAM 3, ALA., 720 North 19th Street
BOSTON 16, MASS., 20 Providence Street, Park Square
BRIDGEPORT 4, CONN., Atlantic Street
BUFFALO 7, N.Y., 1880 Elmwood Avenue
CHARLOTTE 2, N.C., 616 Johnston Building
CHATTANOOGA 2, TENN., 1205 Volunteer Building
CHICAGO 11, ILL., 520 North Michigan Avenue
CINCINNATI 6, OHIO, 2331 Victory Parkway
CLEVELAND 13, OHIO, 1450 Terminal Tower
COLUMBUS 15, OHIO, 40 South Third Street Building
DALLAS 2, TEXAS, 301 Thomas Building
DAVENPORT, IOWA, 503 Kahl Building
DAYTON 5, OHIO, 207 Northtown Arcade
DENVER 6, COLO., 105 Fillmore Street
DETROIT 2, MICH., 610 New Center Building
EVANSVILLE 8, IND., 207 Kinkel Building
FORT WAYNE, IND., 930 Lincoln Bank Tower
GRAND RAPIDS 2, MICH., 812 Michigan National Bank Bldg.
HARTFORD 3, CONN., Capitol Building, 410 Asylum Street
HOUSTON 2, TEXAS, 1804 Commerce Building
INDIANAPOLIS 8, IND., 2939 North Meridian Street
JACKSON, MICH., 1405 National Bank Building
KANSAS CITY 5, MO., 2300 Power & Light Building
LOS ANGELES 17, CALIF., 1145 Wilshire Boulevard
LOUISVILLE 2, KY., 1154 Starks Building
MEMPHIS 3, TENN., 1520 Sterick Building
MIAMI 32, FLA., 1605 Alfred I. du Pont Building
MILWAUKEE 3, WIS., 2040 West Wisconsin Avenue
MINNEAPOLIS 2, MINN., 1060 Northwestern Bank Bldg.
NEWARK 2, N.J., 744 Broad Street
NEW ORLEANS 12, LA., 627 Whitney Building
NEW YORK 17, N.Y., 230 Park Avenue
OKLAHOMA CITY 2, OKLA., 111 N.W. 23rd Street
OMAHA 2, NEB., 746 Omaha National Bank Building
PEORIA, ILL., 725 Commercial Bank Building
PHILADELPHIA 9, PA., 123 South Broad Street
PITTSBURGH 19, PA., 1501 Alcoa Building
PONTIAC 15, MICH., 301 Pontiac State Bank Building
PORTLAND 4, ORE., 1115 U. S. National Bank Building
PROVIDENCE 3, R.I., 2503 Industrial Bank Building
RICHMOND 19, VA., 712 Southern States Building
ROCHESTER 4, N.Y., 1124 Lincoln Alliance Bank Build
ST. LOUIS 8, MO., 10th Floor, Continental Building
SAN FRANCISCO 4, CALIF., 2509 Equitable Life Build
SEATTLE 1, WASH., 1411 Fourth Avenue Building
SOUTH BEND 1, IND., 805 J.M.S. Building
SPOKANE 1, WASH., 610 Fidelity Building
SPRINGFIELD 3, MASS., 508 Tarbell-Watters Building
SYRACUSE 3, N.Y., 731 James Street
TAMPA 2, FLA., 227 First National Bank Building
TOLEDO 4, OHIO, 1801 Owens-Illinois Building
WASHINGTON 6, D.C., 1200 Ring Building
WICHITA 2, KAN., 1011 Central Building
WILMINGTON 1, DEL., 1402 Delaware Trust Building
WORCESTER 8, MASS., 22 Pleasant Street
YORK, PA., 205 Manufacturers Building
YOUNGSTOWN, OHIO, 537 Ohio Edison Building
EXPORT DIVISION, 230 Park Avenue, New York 17, N

The Coal Age Mining Guidebook . . .

Buying Directory

Equipment . . . Materials . . . Services

EQUIPMENT, MATERIALS AND SERVICES FOR COAL MINING, together with the names of those who furnish them, are shown in Part 1 of this Buying Directory, starting on this page.

All products, materials and services, with their suppliers in each instance, are listed alphabetically under the key words. For example, look for "Bearings, Roller," rather than "Roller Bearings." If a product does not appear under one possible classification – for example, "Cable, Welding" – look for the alternative listing – in this instance, "Welding Cable."

BLACK-FACED TYPE indicates a manufacturer or supplier providing more detailed data on available equipment, materials and services through product-information advertisements in this issue (see p 460 for Advertising Index).

THE ADDRESSES of the manufacturers, suppliers and service organizations appearing in the Buying Directory are listed under the company names in the Directory of Manufacturers beginning on p 436 of this issue. For added convenience in obtaining equipment, services and materials offered by advertisers in this issue, their sales offices and representatives are shown in the Advertising Index beginning on p 442. A special Searchlight advertising section is indexed beginning on p 454.

ABRASIVES, DIAMOND, INDUSTRIAL
Metallurgical Products Dept., General Electric Co.

ACETYLENE GENERATORS
Air Reduction Sales Co., Div. of Air Reduction Co., Inc.
Marathon Coal Bit Co., Inc.—"AIRCO"
The Sight Feed Generator Co.—"SIGHT FEED"

ACTUATORS, CYLINDER, LINE VALVES
Ledeen, Inc.

ADDITIVES, FUEL-OIL
Warren Refining & Chemical Co.—"PVR"

ADDITIVES, LUBRICANT
Dow Corning Corp.
E. I. du Pont de Nemours & Co., Inc.
Shell Oil Co.
Stewart-Warner Corp., Alemite Div.
Warren Refining & Chemical Co.—"PVR"

ADHESIVES
B. F. Goodrich Industrial Products Co.—"PLASTILOCK," "VULCALOCK," "DUOLOCK"

AERATORS, BIN
Bin-Dicator Co.—"BIN-FLO"
Convair

AERIAL PHOTOS
Aero Service Corp.
American Air Surveys, Inc.

AERIAL PLATFORMS
Pitman Manufacturing Co.—"GIRAFFE"

AERIAL SURVEYING, MAPPING
Aerial Surveys, Inc.
American Air Surveys, Inc.
Jack Ammann Photogrammetric Engineers, Inc.
Fairchild Aerial Surveys, Inc.

AERIAL TRAMWAYS
Interstate Equipment Corp.
Kurt Orban Co., Inc., Industrial Equipment Div.
Swan Rubber Co.

AFTERCOOLERS, AIR
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Worthington Corp.

AGITATOR CONDITIONERS
The Daniels Co., Contractors, Inc.
Eimco Corp.
Western Machinery Co.—"WEMCO"

AGGREGATE PLANTS
McDowell Co. Inc.—"DWIGHT-LLOYD®"

AIR CLEANERS, COAL
Link Belt Co., Dept. CAMGL-59
Roberts & Shaefer Co., Div. Thompson-Starrett Co., Inc.—"SUPER-AIRFLOW"
Stephens-Adamson Mfg. Co.—"AIR-SAND"

AIR COMPRESSORS
Allis-Chalmers Mfg. Co.
Lincoln Engineering Co., Div. of McNeil Machy. & Engrg. Co.
Schroeder Brothers Corp.

AIR COMPRESSORS, CENTRIFUGAL
Allis-Chalmers Mfg. Co.
American Standard Industrial Div.

AIR COMPRESSORS, DRILL-RIG, POWER TAKEOFF
Davey Compressor Co.

AIR COMPRESSORS, PORTABLE, MINE
Acme Machinery Co.
Airdox Cardox Products Co.—"AIRDOX"
Emglo Products Corp.—"EMGLO"
Gardner-Denver Co.
Imperial-Cantrell Mfg. Co.—"CANTRELL"
Joy Mfg. Co.—"MINEAIR"
Morse Bros. Machinery Co.

AIR COMPRESSORS, PORTABLE, SURFACE
Airdox Cardox Products Co.—"AIRDOX"
Chicago Pneumatic Tool Co.
Davey Compressor Co.—"SUPER CHIEF," "AIR CHIEF," "PERMA-VANE"
Gardner-Denver Co.
Imperial-Cantrell Mfg. Co.—"CANTRELL"
Ingersoll-Rand Co.—"GYRO FLO"
Joy Mfg. Co.—"AIRVANE"
Le Roi Div., Westinghouse Air Brake Co.
Morse Bros. Machinery Co.
Schramm, Inc.—"PNEUMA-POWER," "UNISTAGE," "PNEUMADIESEL"
Worthington Corp.

AIR COMPRESSORS, SELF-PROPELLED
Acme Machinery Co.
Goodman Mfg. Co.
Imperial-Cantrell Mfg. Co.—"CANTRELL"
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Morse Bros. Machinery Co.
Schramm, Inc.—"PNEUMA-TRACTOR"

AIR COMPRESSORS, STATIONARY
Allis-Chalmers Mfg. Co.—"ROFLO"
Airdox Cardox Products Co.—"AIRDOX"
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Emglo Products Corp.—"EMGLO"
Gardner-Denver Co.
Imperial-Cantrell Mfg. Co.—"CANTRELL"
Ingersoll-Rand Co.
Joy Mfg. Co.—"INDUSTRIAL AIR"
Le Roi Div., Westinghouse Air Brake Co.
Morse Bros. Machinery Co.
Nash Engineering Co.
Ore Reclamation Co.
Penn Machine Co.
Pennsylvania Pump & Compressor Co.
Schramm, Inc.—"UNISTAGE"
Worthington Corp.

AIR CONDITIONERS
American-Standard Industrial Div.

AIR-LINE FILTERS
Snap-on Tool Corp.

AIR-LINE OILERS
Acme Machinery Co.
The Branford Co.—"BRANFORD"
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Gardner-Denver Co.
Ingersoll-Rand Co.—"OIL-IR"
Joy Mfg. Co.
Schroeder Bros. Corp.
Stewart-Warner Corp., Alemite Div.
Thor Power Tool Co.

AIR RECEIVERS
Acme Machinery Co.
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Koven Fabricators, Inc.
Pennsylvania Pump & Compressor Co.
Worthington Corp.

AIR SEPARATORS, MECHANICAL
Hardinge Co., Inc.
Majac, Inc., Sub. of Blackstone Corp.

New Jersey Meter Co., Inc.—"DRI-AIR"
Universal Road Machinery Co.—"GAYCO"
Western Precipitation Corp.—"MULTICLONE"
Williams Patent Crusher & Pulv. Co.

AIR SUSPENSIONS

Clark Equipment Co.

ALARMS, BEARING-TEMPERATURE

The Bristol Co.—"BRISTOL'S"
Foxboro Co.
West Instrument Corp.

ALARMS, TRACTOR

E. D. Bullard Co.

ALARMS, TRUCK BACKUP

E. D. Bullard Co.

ALIDADES, PLANETABLE

Kern Instruments, Inc.

ALLOYS, ACID, CORROSION, WEAR-RESISTING

A. M. Byers Co.

ALLOYS, NICKEL

International Nickel Co., Inc.

ALTIMETERS

American Paulin System—"MICRO," "TERRA"

ALUMINUM

Joseph T. Ryerson & Son, Inc.

AMMETERS

National Mine Service Co.

AMMETERS, CLAMP-ON

General Electric Co., Apparatus Sales Div.
Martindale Electric Co.

AMMETERS, INDICATING

General Electric Co., Apparatus Sales Div.
Westinghouse Electric Corp.

AMMETERS, RECORDING

The Bristol Co.—"BRISTOL'S"
General Electric Co., Apparatus Sales Div.
Westinghouse Electric Corp.

AMMONIUM NITRATE, CARBO-NITRATE

Airmite-Midwest, Inc.

AMMONIUM NITRATE, INDUSTRIAL

Allied Chemical Corp., Nitrogen Div.
Austin Powder Co.
Collier Carbon & Chemical Corp.
E. I. du Pont de Nemours & Co., Inc.
Fisher Scientific Co.
Hercules Powder Co.
Industrial Chemicals Div., Spencer Chemical Co.
National Powder Co.

ANALYZERS, COAL-SULPHUR

Fisher Scientific Co.

ANALYZERS, GAS

Hays Corp.

ANALYZERS, SULPHUR, RAPID

Laboratory Equipment Co.—"LECO"

ANALYZERS, VOLATILIZATION

Laboratory Equipment Co.—"LECO"

ANEMOMETERS

Fisher Scientific Co.
Mine Safety Appliances Co.
National Mine Service Co.

ANTIFOAM AGENTS

Hodag Chemical Corp.

ANTI-FOG GOGGLE CLEANER

American Optical Co., Safety Products Div.—"SUPER-CLEAR"
General Scientific Equipment Co.—"GS"
Mine Safety Appliances Co.—"FOGPRUF"
United States Safety Service Co.—"SAF-I-LENS"

ANTIFREEZE

American Minechem Co.
American Oil Co.
E. I. du Pont de Nemours & Co., Inc.—"ZERONE," "ZEREX"

ARCHES, SUSPENDED FURNACE

Bigelow-Liptak Corp.

ARMATURE GROWLERS, TESTERS

Martindale Electric Co.
Snap-on Tools Corp.

ARMATURE REWINDING

Flood City Brass & Electric Co.
Guyan Machy. Co.
National Mine Service Co.
Pennsylvania Electric Coil Corp.
Scranton Electric Construction Co.
West Virginia Armature Co.
Westinghouse Electric Corp.

ARMATURE TOOLS

Martindale Electric Co.

ASHING EQUIPMENT, RAPID

Laboratory Equipment Co.—"LECO"

ATHLETE'S-FOOT PREVENTIVE

Onox, Inc.—"ONOX"

AUGER EXTENSIONS

Airdox Cardox Products Co.
The Leetonia Tool Co.
Mobile Drilling, Inc.

AUGER FLIGHTS, CUTTER HEADS

Acker Drill Co., Inc.

AUGER SOCKETS

Airdox Cardox Products Co.
The Leetonia Tool Co.
Mobile Drilling, Inc.

AUGERS, BREAST

Marathon Coal Bit Co., Inc.—"SALEM"
The Salem Tool Co.—"SALEM"

AUGERS, COAL-RECOVERY

Airdox Cardox Products Co.
Compton, Inc.
Link-Belt Co., Dept. CAMGL—59
Marathon Coal Bit Co., Inc.—"SALEM"
The Salem Tool Co.—"McCARTHY"
Taylor-Wharton Co., Div. Harsco Corp.

AUGERS, COAL-SHOTHOLE

Airdox Cardox Products Co.
Central Mine Equipment Co.
Dooley Bros.
Kennametal Inc., Mining Tool Div.
Marathon Coal Bit Co. Inc.—"McLAUGHLIN"
McLaughlin Mfg. Co., Inc.
Metallurgical Products Dept. General Electric—"CARBOLOY"
Mobile Drilling, Inc.
The Salem Tool Co.—"HERCULES"
Schroeder Bros. Corp.

AUGERS, EARTH

Acker Drill Co., Inc.—"ALL-PURPOSE (AP) DIGGER"
Airdox Cardox Products Co.
Central Mine Equipment Co.
FWD Corp.
H & L Tooth Co.
Herb J. Hawthorne, Inc.—"BLUE DEMON"
The Leetonia Tool Co.
Link-Belt Co. Dept. CAMGL—59
Marathon Coal Bit Co., Inc.—"McLAUGHLIN"
McLaughlin Mfg. Co., Inc.
Mobile Drilling, Inc.
Pennsylvania Drilling Co.
The Salem Tool Co.—"BLACK DIAMOND"
The Wood Shovel & Tool Co.

AUGERS, ROCK-BLASTHOLE

Airdox Cardox Products Co.
Central Mine Equipment Co.
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Marathon Coal Bit Co. Inc.—"McLAUGHLIN"
Metallurgical Products Dept., General Electric Co.—"CARBOLOY"
Mobile Drilling, Inc.
The Salem Tool Co.—"McCARTHY"

AUGERS, ROOF DRILL

Airdox Cardox Products Co.
Kennametal Inc., Mining Tool Div.

AUGERS, UNDERGROUND

The Salem Tool Co.

AUTOMATIC SPRINKLERS

The Fyr-Fyter Co.

AXES, MINERS'

American Logging Tool Corp., Sub. of Broderick & Bascom Rope Co.—"AMERICAN," "RIXFORD," "AMERICAN CLIPPER," "ETHAN ALLEN"

AXLES, CARS, MINE EQUIPMENT

American Car & Foundry Div., ACF Industries, Inc.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Flood City Brass & Electric Co.
Gibraltar Equipment & Mfg. Co.—"GEMCO TRU-BLU"
Irwin-Sensenich Corp.
Kanawha Mfg. Co.
Sanford Day Iron Works, Inc.
Sterling Steel Casting Co.
Watt Car & Wheel Co.

AXLES, DRIVE, STEERING, AUTOMOTIVE SPECIAL

Clark Equip. Co., Automotive Div.

AXLES, FRONT, DRIVING

Transmission and Axle Div., Rockwell Standard Corp.

AXLES, FRONT, NON-DRIVING

Transmission and Axle Div., Rockwell Standard Corp.

AXLES, PLANETARY, STEERING AND RIGID

Transmission and Axle Div., Rockwell Standard Corp.

AXLES, REAR, SINGLE, TANDEM

Transmission and Axle Div., Rockwell Standard Corp.

AXLES, TRAILER, TUBULAR AND I SECTION

Transmission and Axle Div., Rockwell Standard Corp.

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BACKSTOPS

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Barber-Greene Co.
Chain Belt Co.—"REX"
Continental Gin Co., Ind. Div.
Hewitt-Robins Incorporated—"JONES"
Kremser & Sons, Inc., Frank A.
Link-Belt Co., Dept. CAMGL-59
Marland One-way Clutch Co.
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
Webster Mfg., Inc.

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Bemis Bro. Bag Co.
C. R. Daniels Co.
The Daniels Co., Contractors, Inc.
The Ducon Co., Inc.
John Flocker & Co.
Koppers Co., Inc., Metal Products Div.
National Filter Media Corp.
Western Precipitation Corp.—"DUALAIRE," "THERM-O-FLEX"
Wheelabrator Corp.

BAGS, COAL WASHING FILTER

National Filter Media Corp.

BAGS, DISK-FILTER

Elmco Corp.

BAGS, DISK-FILTER STAINLESS WIRE

Peterson Filters & Engineering Co.

BAGS, DUST COLLECTOR

National Filter Media Corp.

BAGS, EXPLOSIVES

Bemis Bro. Bag Co.

BAGS, MULTIWALL

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Bemis Bro. Bag Co.—"FLIP-CLOSE"
Chase Bag Co.
Elmco Corp.
Peterson Filters & Engineering Co.—"SARAN"
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Chase Bag Co.
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National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.
Tamping Bag Co., Div., Pickard Industries, Inc.

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Chase Bag Co.

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SKF Industries, Inc.

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Dravo Corp.
Hewitt-Robins Incorporated
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-59
McNally-Pittsburg Mfg. Corp.
Roberts & Schaefer Co., Div. Thompson Starrett Co., Inc.
Sanford Day Iron Works, Inc.
Stephens-Adamson Mfg. Co.

BARGES

Bethlehem Steel Co.
Dravo Corp.
Marietta Manufacturing Co.
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BAROGRAPHS

American Paulin System—"MICRO" "TERRA"

BAROMETERS

American Paulin System—"MICRO," "TERRA"
The Bristol Co.—"BRISTOLS"
Fisher Scientific Co.

BARS, APPLICATOR

Stula-Sickles Co. —"MANGANAL"

BARS, COLD-FINISHED

H. K. Porter Co., Connors Steel Div.

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American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
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National Malleable & Steel Castings Co.
Nordberg Mfg. Co.
Roberts & Schaefer Co. Div. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.

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H. K. Porter Co., Connors Steel Div.

BARS, SLATE

Duquesne Mine Supply Co.
The Leetonia Tool Co.
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Gibraltar Equipment & Mfg. Co.

BASKETS, CLOTHES

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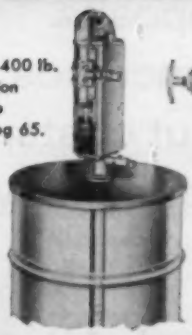

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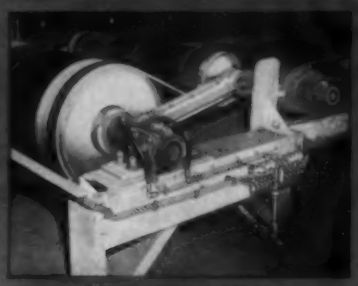

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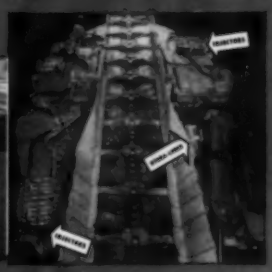
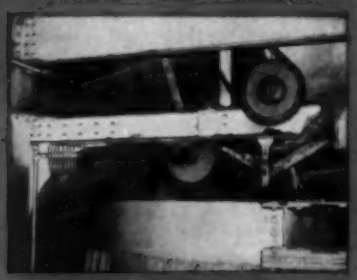
BELT DRIVES





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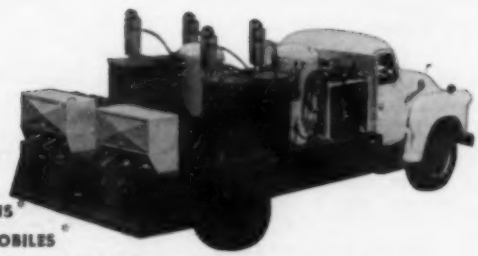

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C & D Batteries, Inc.—"AUTOREG"
Cornell-Dubilier Electric Corp.—"POWERCON"
Exide Industrial Div., The Electric Storage Battery Co.
General Electric Co., Apparatus Sales Div.
General Scientific Equipment Co.—"GS"
Gould-National Batteries, Inc.
Hobart Bros. Co.
Ironton Engine Co.—"IRONTON"
Joy Mfg. Co.
Kersey Mfg. Co., Inc.
The Lincoln Electric Co.—"PRECISION-CHARGE"
Mine-Safety Appliances Co.
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Westinghouse Electric Corp.

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American Brake Shoe Co., National Bearing Div.
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Imperial-Cantrell Mfg Co.—"IC"
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Bantam Bearings Div., Torrington Co.
Bearings Service Co.
Bearings, Inc.
Continental Gin Co., Ind. Div.
Dodge Mfg. Corp.—"SC," "SLP," "SCM"
Ensign Electric & Mfg Co.
The Fafnir Bearing Co.
The Federal Bearings Co., Inc.
Federal-Mogul Service, Div. of Federal-Mogul-Bower Bearings, Inc.—"BCA"
Flood City Brass & Electric Co.
Guyan Machy Co.
Link-Belt Co.—Dept. CAMGL-59 —"JPS"
Marlin-Rockwell Corp.—"M-R-C"
McNally-Pittsburg Mfg. Corp.
Mosebach Electric & Supply Co.
National Mine Service Co.
New Departure Div., General Motors Corp.
Norma-Hoffman Bearings Corp.
SKF Industries, Inc.
Ore Reclamation Co.
Stephens-Adamson Mfg. Co.—"SEALMASTER"
Torrington Co.
Transall, Inc.
T. B. Woods Sons Co.—"LIFE LUBE"
West Virginia Armature Co.

BEARINGS, BRONZE

American Brake Shoe Co., National Bearing Div.
Gibraltar Equipment & Mfg. Co.—"FRICTION FIGHTER"
Link-Belt Co., Dept. CAMGL-59

BEARINGS, CARBON

Helwig Carbon Products, Inc.
Ohio Carbon Co.—"KARAK"
Pure Carbon Co., Inc.

BEARINGS, HANGER

Link-Belt Co., Dept. CAMGL-59
Vickers, Inc.—"TULSA (Two speed)"

BEARINGS, JOURNAL

American Brake Shoe Co., National Bearing Div.
American Brake Shoe Co., Railroad Products Div.

BEARINGS, NEEDLE

Bantam Bearings Div., Torrington Co.
Bearing Service Co.
Bearings, Inc.
Torrington Co.

BEARINGS, ROLLER

Bantam Bearings Div., Torrington Co.
Bearing Service Co.
Bearings, Inc.
Chain Belt Co.—"SHAFER"
Chain Belt Co., Shafer Bearing Div.—"SHAFER SELF-ALIGNING"
Continental Gin Co., Ind. Div.
Dodge Mfg. Corp.—"SPHER-ALIGN"
Enterprise Wheel & Car Corp.
Federal-Mogul Service, Div. of Federal-Mogul-Bower Bearings, Inc.—"BOWER"
Gibraltar Equipment & Mfg. Co.—"FRICTION FIGHTER"
Guyan Machy. Co.
Hyatt Bearings Div., General Motors Corp.
Link-Belt Co., Dept. CAMGL-59 —"LINK-BELT," "MILL BEARING," "SPHERICAL"
Marlin-Rockwell Corp.—"M-R-C"
McNally-Pittsburg Mfg. Corp.
Mosebach Electric & Supply Co.
National Mine Service Co.
Norma-Hoffmann Bearings Corp.
Ore Reclamation Co.
Rollway Bearing Co., Inc.
SKF Industries, Inc.
Torrington Co.
West Virginia Armature Co.

BEARINGS, ROLLER, SPLIT

Bearing Service Co.
Bearings, Inc.
Link-Belt Co., Dept. CAMGL-59
Transall, Inc.

BEARINGS, SLEEVE

Allison Div., General Motors Corp.
American Brake Shoe Co., National Bearing Div.
American Crucible Products Co.
Ampco Metal, Inc.—"AMPCO"
Bearings, Inc.
Dodge Mfg. Corp.—"SLEEVOIL"
Flood City Brass & Electric Co.
Imperial-Cantrell Mfg. Co.—"IC"
Johnson Bronze Co.
Link-Belt Co., Dept. CAMGL-59 —"LINK-BELT"
Mosebach Electric & Supply Co.
Bertrand P. Tracy Co.
Transall, Inc.
Webster Mfg., Inc.
West Virginia Armature Co.

BEARINGS, SLEEVE, CONVERSION

Bearings, Inc.
Imperial-Cantrel Mfg. Co.—"IC"
Johnson Bronze Co.
West Virginia Armature Co.

BEARINGS, SLEEVE, SELF-LUBRICATING

Keystone Carbon Co.

BEARINGS, TAPERED ROLLER

Federal-Mogul Service, Div. of Federal-Mogul-Bower Bearings, Inc.—"BOWERS"
SKF Industries, Inc.—"TYSON"
The Timken Roller Bearing Co.
Tyson Bearing Co., Div. of SKF Industries, Inc.

BEARINGS, THRUST

Bantam Bearings Div., Torrington Co.
Bearings, Inc.
Bearing Service Co.
Federal-Mogul Service, Div. of Federal-Mogul-Bower Bearings, Inc.—"BCA"
Gibraltar Equipment & Mfg. Co.—"FRICTION FIGHTER"
The Federal Bearings Co. Inc.
Johnson Bronze Co.
Link-Belt Co., Dept. CAMGL-59
Marlin-Rockwell Corp.—"M-R-C"
New Departure Div., General Motors Corp.
Norma-Hoffmann Bearings Corp.
Ore Reclamation Co.
Rollway Bearing Co., Inc.
SKF Industries, Inc.
Torrington Co.

BELT CLAMPS

Transall, Inc.

BELT-LOADING STATIONS, AUTOMATIC

General Equipment & Manufacturing Co.
Link-Belt Co., Dept. CAMGL-59
Nolan Co.

BELTS, CHAIN

Link-Belt Co., Dept. CAMGL-59

BELTS, FLAT TRANSMISSION

Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Carlyle Rubber Co., Inc.
Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co.
C. R. Daniels Co.
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.—"HIGH FLEX"
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Manheim Mfg. & Belting Co.
Ore Reclamation Co.
Paltech Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div. — "CONDOR"
Republic Rubber Div., Lee Rubber & Tire Co.—"CHALLENGER"
Scandinavia Belting Co.— "SCANDINAVIA," "SCANDILEX"
Talcott, Inc.
Thermoid Co.
Thermoid Div., H. K. Porter Co. Inc.
Transall, Inc.
United States Rubber Co.

BELTS, MINERS LEATHER

National Mine Service Co.

BELTS, POWER TRANSMISSION

Extremultus, Inc.

BELTS, V

Allis-Chalmers Mfg. Co.—"TEXROPE"
American Pulley Co.—"WEDGBELT"
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Browning Mfg. Co.
Carlyle Rubber Co., Inc.
J. D. Christian Engineers
Dodge Mfg. Corp.—"SEALED-LIFE," "DYNA-V"
Flood City Brass & Electric Co.
The Gates Rubber Co. Sales Div., Inc.
Goodall Rubber Co.
Goodrich Co., B. F. Industrial Products Div.—"GROMMET"
Goodyear Tire & Rubber Co.
Guyn Machy. Co.
Link-Belt Co., Dept. CAMGL-59
Mosebach Electric & Supply Co.
National Mine Service Co.
Ore Reclamation Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.—"CONDOR," "SUPER-POWER"
Republic Rubber Div., Lee Rubber & Tire Co.—"CHAMPION"
Thermoid Co.
Thermoid Div., H. K. Porter Co. Inc.
Transall, Inc.
United States Rubber Co.
T. B. Woods Sons Co.—"SURE GRIP"
Worthington Corp.

BELTS, V-LINK

Guyan Machy. Co.
National Mine Service Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
T. B. Woods Sons Co.—"SURE LINK"

BELTS, V-LINK ADJUSTABLE

Manheim Mfg. & Belting Co.—"VEELOS V"

BENDERS, PIPE, BAR STOCK, ANGLE IRON, O. D. TUBING, RIGID CONDUIT

Farrell-Cheek Steel Co.
Hossfeld Mfg. Co.—"HOSSFELD UNIVERSAL"

BENDERS, PIPE, CONDUIT

Blackhawk Mfg. Co.
National Electric Products Co.

BINDERS, LOAD

American Logging Tool Corp., Sub. of Broderick & Bascom Rope Co.
Coffing Hoist Div., Duff-Norton Co.
Crosby Laughlin Div. American Hoist & Derrick Co.—"LEBUS"
Gibraltar Equipment & Mfg. Co.

BIN DEVICES

Fairmont Machinery Co.— "EASY-FLO"

BIN GATES

Blaw-Knox Co., Blaw-Knox Equipment Div.
C. S. Card Iron Works
Chain Belt Co.—"REX"
Helmick Foundry-Machine Co.
Hewitt-Robins Incorporated
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-59
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Ore Reclamation Co.
Pioneer Engineering, Div. of Poor & Co.
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.
Smith Engineering Works—"TELSMITH" "MOORE," "DUPLEX," "TRIPLEX"
Stephens-Adamson Mfg. Co.—
Thomas Engineering & Construction Co.
Webster Mfg., Inc.
Wilmot Engineering Co.

BIN-LEVEL INDICATORS

Bin-Dicator Co.—"BINDICATOR" "BANTAM BINDICATOR," "ROTO BINDICATOR," "AUTO-BIN-DICATOR"
Convair—"BIN-VUE"
Hewitt-Robins Incorporated—"ROBINTRONIC"
Industrial Physics & Electronics Co.—"TRANSIST-O-TROL"
Jeffrey Mfg. Co.—"BIN-EYE"
Stephens-Adamson Mfg. Co.—"TELEVEL"

BIN VIBRATORS

The Branford Co.—"BRANFORD"
Cleveland Vibrator Co.
Eries Mfg. Co.
W. S. Tyler Co.—"TY-SPEED"

BINS, COAL STORAGE, BLENDING, SLATE

Barber-Greene Co.
Diamond Iron Works, Div. Goodman Mfg. Co.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-59
The Neff & Fry Co.

BINS, PARTS-STORAGE

The Frick-Gallagher Mfg. Co.—"ROTABINS"
Kanawha Mfg. Co.
McNally-Pittsburg Mfg. Corp.

BINS & HOPPERS, COAL-STORAGE, BLENDING

Bathlehem Steel Co.
The Daniels Co., Contractors, Inc.
Enterprise Wheel & Car Corp.
Fairmont Machinery Co.
Hammermills, Inc.
Robert Holmes & Bros., Inc.
Irwin-Sensenich Corp.
Kanawha Mfg. Co.
Koven Fabricators, Inc.
Link-Belt Co., Dept. CAMGL-59
Meckum Engineering, Inc.
Marietta Concrete Div. of American-Marietta Co.
E. F. Marsh Engrg. Co.—"MARCO"
McNally Pittsburg Mfg. Corp.
Ore Reclamation Co.
Pioneer Engineering, Div. of Poor & Co.
K. Prins & Associates
Roberts & Schaefer Co., Div. Thompson Starrett Co., Inc.
Thomas Engineering & Construction Co.

BIT BOXES

Duquesne Mine Supply Co.

BIT HOLDERS, MULTIPLE, INDIVIDUAL

Frank Prox Co., Inc.

BIT-RESETTING SERVICE, DIAMOND

Hoffman Bros. Drilling Co.
Joy Mfg. Co.
J. K. Smit & Sons, Inc.
Sprague & Henwood

BIT SHARPENERS, COAL BITS

Fairview Bit Co.
Joy Mfg. Co.

HOYT WIRE SCREENS

. . . Installed As Original Equipment For Moss #3 Preparation Plant

Everything about the new Moss No. 3 Preparation Plant, Clinchfield Coal Company, Dante, Virginia, is as modern and efficient as human ingenuity can make it. For maximum screening and sizing efficiency, HOYT Wire Screens were specified. For the larger openings, where maximum open area and wear life were required. HOYT Supertough (Oil Tempered) Wire Screens, Smoothtop construction, were installed. For the smaller specifications, where corrosion and abrasion were wear factors, HOYT Spring Grade Stainless Steel Wire Screens (Type 302, Rockwell "C" hardness of 40, tensile strength 235,000 psi) were installed. During plant construction, after the vibrating screens had been installed, a HOYT team surveyed each station, listing pertinent data such as: (1) anticipated sizing opening and wire diameter; (2) vibrator dimensions affecting wire cloth panel specifications, including overlap requirements, location of center line bolt holes, proper outside clamping width, etc.; (3) height, drop of feed to top deck; (4) anticipated moisture content and load on each deck. This information was translated into a HOYT Wire Cloth Survey and Recommendation Report. Subsequent requirements have been supplied by reference to these key facts. Like surveys have been made for all Clinchfield operations, including the new lightweight aggregate plant. Each is used as reference when changes are contemplated or orders entered.

A HOYT Screen Survey Is Yours For The Asking

To find out whether your screening stations are operating at peak efficiency, let us survey your requirements. Many plants report that our recommendations have increased production up to 15 percent without additional investment.

HOYT Wire Screens deliver materials to meet the most exacting requirements . . . with less down-time and fewer screen changes. They offer practical proof that highest quality pays off in maximum efficiency and lowest net-cost-per-ton. Write today for details.

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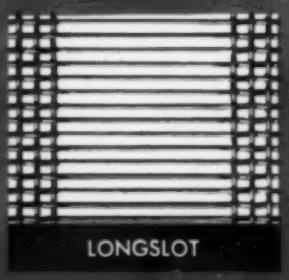
HOYT WIRE CLOTH COMPANY

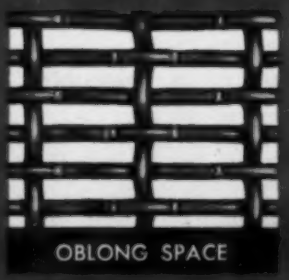
P. O. BOX 1577, LANCASTER, PA. • PHONE EXpress 4-6871

SMOOTHTOP



LONGSLOT

DOUBLE CRIMP



OBLONG SPACE

BIT SHARPENERS, ROCK BITS

Bucyrus-Erie Co.
Fairview Bit Co.
Hoffman Bros. Drilling Co.
Ingersoll-Rand Co.
Joy Mfg. Co.

BIT-SHARPENING SERVICE

Brunner & Lay-Eastern, Inc.
Fairview Bit Co.
Hoffman Bros. Drilling Co.
Howells Mining Drill Co.
Marathon Coal Bit Co. Inc.

BITS, CUTTER

Herold Mfg. Co.

BITS, CUTTER, ALLOY-STEEL

Airdox Cardox Products Co.
The Bowdil Co.
Central Mine Equipment Co.—"KERFMASTER"
Cincinnati Mine Machinery Co.—"CINCINNATI," "DUPLEX-TIPPED"
Crucible Steel Co. of America—"REX"
Cutter Bit Service Co.—"CUTRITE"
H & L Tooth Co.
Marathon Coal Bit Co. Inc.—"CRUCIBLE"
The Salem Tool Co.—"HERCULES"

BITS, CUTTER CARBIDE-INSERT

Airdox-Cardox Products Co.
Allegheny Ludlum Steel Corp.—"CARMET"
Austin Powder Co.
The Bowdil Co.
Cincinnati Mine Machinery Co.—"CINIDE"
Cutter Bit Service Co.— "CUTRITE"
Firth Sterling, Inc.— "FIRTHITE"
Guyan Machy. Co.
Hoffman Bros. Drilling Co.
Kennametal, Inc., Mining Tool Div.
Marathon Coal Bit Co. Inc.—"CARBOLOY," "BORDER CITY"
Metal Carbides Corp.
Metallurgical Products Dept. General Electric Co.—"CARBOLOY"
Mobile Drilling, Inc.
National Mine Service Co.
Newcomer Products, Inc.
The Salem Tool Co.—"SALEM"
Vascoloy-Ramet Corp.

BITS, CUTTER, CARBON-STEEL

Austin Powder Co.
Crucible Steel Co. of America
Cutter Bit Service Co.—"CUTRITE"
Howells Mining Drill Co.
Joy Mfg. Co.
The Leetonia Tool Co.
Marathon Coal Bit Co. Inc. —"UNION FORGE"
The Salem Tool Co.—"BLACK DIAMOND"

BITS, CUTTER, HARD-SURFACED, PLATED, TIPPED

Airdox Cardox Products Co.
The Bowdil Co.
Central Mine Equipment Co.—"KERFMASTER"
Cutter Bit Service Co.—"CUTRITE"
Mobile Drilling, Inc.
The Salem Tool Co.—"SALEM"

BITS, CUTTER, HARD-SURFACED, TIPPED

Cincinnati Mine Machinery Co.—"CINCINNATI," "DUPLEX-TIPPED"
Frank Prox Co., Inc.

BITS, CUTTER, THROWAWAY

Airdox Cardox Products Co.
The Bowdil Co.
Central Mine Equipment Co.—"KERFMASTER"
Cincinnati Mine Machinery Co.—"DUPLEX," "STANEX"
Hoffman Bros. Drilling Co.
Marathon Coal Bit Co. Inc.—"MARATHON," "COAL MASTER"
Mobile Drilling, Inc.
National Mine Service Co.
Penn Machine Co.
Frank Prox Company, Inc.—"TOOL STEEL"
The Salem Tool Co.—"SALEM"

BITS, DOWN-THE-HOLE

Stardrill-Keystone Co., Div. of Koehring Co.

BITS, DRILL, AUGER, CARBIDE TIPPED

Vascoloy-Ramet Corp.

BITS, DRILL, CHURN

Spang & Co.

BITS, DRILL, COAL

Airdox Cardox Products Co.
Austin Powder Co.
Central Mine Equipment Co.—"COALMASTER"
Compton, Inc.
Dooley Brothers
Gibraltar Equipment & Mfg. Co.
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Howells Mining Drill Co.
Kennametal Inc., Mining Tool Div.
Marathon Coal Bit Co., Inc.—"McLAUGHLIN," "COALMASTER"
McLaughlin Mfg. Co., Inc.
Mobile Drilling, Inc.
National Mine Service Co.
Newcomer Products, Inc.
Paris Mfg. Co.
The Salem Tool Co.—"SALEM"

BITS, DRILL, COAL, CARBIDE-TIPPED

Airdox Cardox Products Co.
Allegheny Ludlum Steel Corp.—"CARMET"
Austin Powder Co.
Brunner & Lay-Eastern, Inc.
Firth Sterling, Inc.—"FIRTHITE"
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Hoffman Bros. Drilling Co.
Howells Mining Drill Co.
Kennametal Inc., Mining Tool Div.
Marathon Coal Bit Co., Inc.—"CARBOLOY," "BORDER CITY"
McLaughlin Mfg. Co., Inc.
Metal Carbides Corp.
Metallurgical Products Dept., General Electric Co.—"CARBOLOY"
Mobile Drilling, Inc.
Newcomer Products Inc.
Paris Mfg. Co.
Frank Prox Company, Inc.—"PT-1," "PT-2"
The Salem Tool Co.—"SALEM"
Vascoloy-Ramet Corp.

BITS, DRILL, CORE

George E. Failing Co., Sub. of Westinghouse Air Brake Co.
Hoffman Bros. Drilling Co.
Joy Mfg. Co.
Kennametal Inc., Mining Tool Div.
Mobile Drilling, Inc.
Newcomer Products, Inc.
Pennsylvania Drilling Co.
Sprague & Henwood
Varel Mfg. Co., Inc.

BITS, DRILL, CORE, DIAMOND, CARBIDE, SHOT, SAWTOOTH

Acker Drill Co. Inc.

BITS, DRILL, DIAMOND

Diamdon Tool Research Co., Inc. —"DTR"
George E. Failing Co., Sub. of Westinghouse Air Brake Co.
Hoffman Bros. Drilling Co.
Joy Mfg. Co.—"TRUCO"
Metal Carbides Corp.
Mobile Drilling, Inc.
Pennsylvania Drilling Co., Masonry Drill Div.
J. K. Smit & Sons, Inc.—"HARHED"
Sprague & Henwood
Varel Mfg. Co., Inc.

BITS, DRILL, DIAMOND, RESETTING SERVICE

Diamond Tool Research Co., Inc.
Sprague & Henwood

BITS, DRILL, MASONRY

Pennsylvania Drilling Co., Masonry Drill Div.

BITS, DRILL, MOLEFOOT, STRIPPING

Airdox Cardox Products Co.
Central Mine Equipment Co.—"COALMASTER"
Marathon Coal Bit Co. Inc.—"McLAUGHLIN," "CARBOLOY"
Mobile Drilling, Inc.
Paris Mfg. Co.
The Salem Tool Co.—"SALEM"

BITS, DRILL, PERCUSSION

Acme Machinery Co.
Brunner & Lay-Eastern, Inc.
Bucyrus-Erie Co.
Gardner-Denver Company
Guyan Machy. Co.—"THROWAWAY"
Ingersoll-Rand Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Mobile Drilling, Inc.
Schroeder Brothers Corp.

BITS, DRILL, PERCUSSION, CARBIDE-INSERT, ALL STEEL MULTI-USE

The Timken Roller Bearing Co.

BITS, DRILL, PERCUSSION, CARBIDE-TIPPED

Airdox Cardox Products Co.
Brunner & Lay-Eastern, Inc.—"ROK-BITS"
Joy Mfg. Co.
Ingersoll-Rand Co.—"CARSET".
Kennametal Inc., Mining Tool Div.
Marathon Coal Bit Co. Inc.—"TIMKEN"
Metal Carbides Corp.
Newcomer Products, Inc.
B. J. Nykerk Corp.—"HAUSHERR"
Vascoloy-Ramet Corp.

BITS, DRILL, ROOF

J. H. Fletcher & Co. (Key Type)

BITS, DRILL ROOF-CARBIDE-TIPPED

Airdox Cardox Products Co.
Allegheny Ludlum Steel Corp.—"CARMET"
Austin Powder Co.
Brunner & Lay-Eastern, Inc.—"INTRASET"
Firth Sterling, Inc.—"FIRTHITE"
Guyan Machy. Co.—"FIRTHITE"
Kennametal Inc., Mining Tool Div.
Marathon Coal Bit Co. Inc.—"CARBOLOY," "BORDER CITY"
Metal Carbides Corp.
Metallurgical Products Dept., General Electric Co.—"CARBOLOY"
Newcomer Products, Inc.
Frank Prox Company, Inc.
Vascoloy-Ramet Corp.

BITS, DRILL, ROTARY, AIR, BLASTHOLE

Acker Drill Co., Inc.
Airdox Cardox Products Co.
Austin Powder Co.
Central Mine Equipment Co.—"COALMASTER"
George E. Failing Co., Sub. of Westinghouse Air Brake Co.
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Hoffman Bros. Drilling Co.
Hughes Tool Co.
Kennametal Inc., Mining Tool Div.
Marathon Coal Bit Co. Inc.—"McLAUGHLIN," "CARBOLOY"
H. C. Smith Oil Tool Co.
Stardrill-Keystone Co., Div. of Koehring Co
Varel Mfg. Co., Inc.—"AIRBLAST"

BITS, DRILL, ROTARY, WATER, EXPLORATION

Hughes Tool Co.

BITS, DRILL, ROTARY, WET, BLASTHOLE

Airdox Cardox Products Co.
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Hoffman Bros. Drilling Co.
Marathon Coal Bit Co. Inc.—"CARBOLOY," "C. P. ROTARY"
H. C. Smith Oil Tool Co.
Varel Mfg. Co., Inc.

BITS, DRILL, ROTARY, WET, CARBIDE-TIPPED, STRIPPING

Allegheny Ludlum Steel Corp.—"CARMET"
Firth Sterling, Inc.—"FIRTHITE"
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Marathon Coal Bit Co. Inc.—"CARBOLOY"
Metal Carbides Corp.
Metallurgical Products Dept., General Electric Co.—"CARBOLOY"
Vascoloy-Ramet Corp.

BITS, FINGER, CARBIDE-TIPPED

Airdox Cardox Products Co.
Firth Sterling Inc.—"FIRTHITE"
Vascoloy-Ramet Corp.

BITS, ROCK, CONE-TYPE-ROLLER

Herb J. Hawthorne, Inc.

BITS, STRIP, FINGER, CARBIDE-TIPPED

Airdox Cardox Products Co.
Firth Sterling Inc.—"FIRTHITE"

BLADE CONTROLS, AUTOMATIC-GRADER

Preco Incorporated—"PRECO"

BLASTING AGENTS

American Cyanamid Co., Explosives and Mining Chemicals Dept.—"CYAMITE," "ACCOMITE," "CYAMON"
Atlas Powder Co.—"AMOCOL," "AMOFLO," "CHEMEX," "ATLAS GRANULES," "ATLAS PRILLS," "GIANITE"
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc.—"NITRAMEX," "NITRAMITE," "NITRAMON"
Hercules Powder Co.

BLASTING CAPS

American Cyanamid Co., Explosives and Mining Chemicals Dept.
Atlas Powder Co.—"MANASITE"
E. I. du Pont de Nemours & Co., Inc.
Hercules Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.—"BIG INCH"

BLASTING CAPS, ELECTRIC

Atlas Powder Co.—"MANASITE," "ROCKMASTER"

BLASTING MACHINES

American Cyanamid Co., Explosives and Mining Chemicals Dept.
Atlas Powder Co.—"SHOTMASTER"
Hercules Powder Co.

BLASTING METERS

Hercules Powder Co.—"VAO"

BLASTING WIRE

American Cyanamid Co., Explosives and Mining Chemicals Dept.
Atlas Powder Co.

BLASTING WIRE, CORD

Cornish Wire Co., Inc.
E. I. du Pont de Nemours & Co., Inc.
Kaiser Aluminum & Chemical Sales, Inc.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.
Rome Cable Corp.
The Salem Tool Co.—"SALEM"

BLENDERS

Stedman Foundry & Machine Co., Inc.

BLENDING AND PROPORTIONING SYSTEMS

ABC's® Scale Div., McDowell Co., Inc.

BLOCK SIGNALS, AUTOMATIC

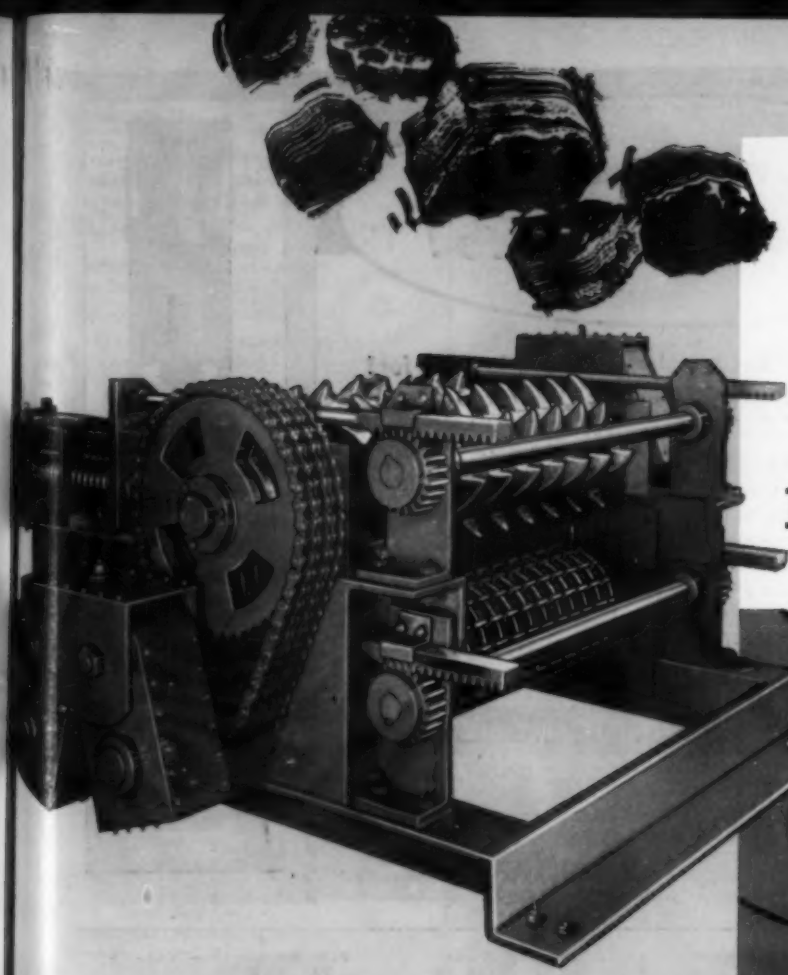
American Mine Door Co.
General Equipment & Mfg. Co.
Nachod & U.S. Signal Co.

BLOCKS, CRANE-HOOK

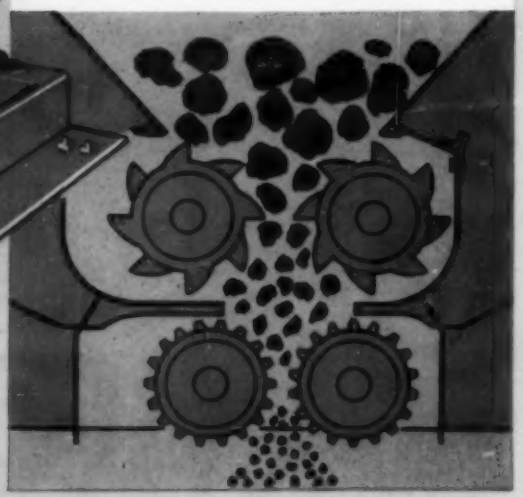
The Upson-Walton Co.— "MAX-LIFT"

BLOCKS, MANILA-ROPE

The Upson-Walton Co.



GUNDLACH takes the Crushing Problem Down to Size!



YOU BENEFIT . . .

By Control of Top Size — Crushing to size in one operation eliminates recirculating load . . . saves time and equipment . . . increases overall plant capacity.

By Less Fines — More saleable coal in stoker sizes means more dollars per ton . . . if crushing prior to washing, fewer fines means lower washing costs.

By Flexibility . . . Can handle larger lumps and frozen coal . . . hand wheel adjustment allows you to fill any order down to ¾" top size . . . orders heretofore uneconomical to fill are now yours.

By Dependability . . . Ever-increasing list of satisfied users.

By Economical Operation . . . Less maintenance . . . Less H.P. per ton of crushed coal . . . One Crusher . . . Lower initial investment . . . No wasted labor in adjusting crusher.

YOUR CUSTOMER BENEFITS . . .

By Control of Top Size . . . More BTU output per ton . . . Less unburnt coal in ashes . . . Lower ash handling costs . . . . Greater overall utilization.

By Less Fines . . . Simplifies unloading . . . increases boiler efficiency.

Uniformity in size consist of GUNDLACH crushed coal eliminates customer complaints, gives customer satisfaction, and increases production.

Yes, greater efficiency, dependability and lower operating and maintenance costs make the GUNDLACH crusher the mine owner's best investment.

A GUNDLACH Crusher not only saves you money, it makes you money.

If you have a crushing problem, you'll find a GUNDLACH representative as near as your telephone.

T. J. GUNDLACH MACHINE CO.
P. O. BOX 283 • BELLEVILLE, ILL.
Division of J. M. J. Industries

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CLYDE E. CLARKSON, 4831 E. Harvard Lane, Denver, Colo., SK 6-5377 SCHONTHAL & ASSOCIATES, Suite 309, 224 S. Michigan Ave., Chicago 4, Ill., WA 2-8350
A. R. AMOS COMPANY, 713 Commercial Trust Bldg., Philadelphia, Pa., RI 6-3675 RICHARD M. WILSON, 27 Oak Park, Wheeling, W. Virginia, Woodsdale 336

For fast, easy installations...
BOLT WITH "Top-Tite"!
Here's what bolting people have been looking for!
A STEEL SHELL that leads the way in...
TIGHTENING...HOLDING POWER...RELIABILITY
You can cut your bolting time *and bolting costs as well* by using "Top-Tite" shells. "Top-Tite" gives you maximum expansion in minimum time!
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Hauck Mfg. Co.
Ilg Electric Ventilating Co.—"ILG"
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Jeffrey Mfg. Co.
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Westinghouse Electric Corp., Sturtevant Div.

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F. R. Hannon & Sons — "HANCO"
Joy Mfg. Co.—"AXIVANE"
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Westinghouse Electric Corp., Sturtevant Div.

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Holub Industries, Inc.
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Westinghouse Electric Corp., Sturtevant Div.

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Mine Safety Appliances Co.

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Thermoid Co.
Wagner Electric Corp.
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National Electric Products Co.
National Mine Service Co.
Okonite Co.
Phelps Dodge Copper Products Co.
Rockbestos Products Corp., Sub. of Cerro de Pasco Corp.—"ROCKBESTOS A.V.C."
Triangle Conduit & Cable Co. Inc.

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Rome Cable Corp.
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Circle Wire & Cable Corp.
Copperweld Steel Co., Wire & Cable Div.—"COPPER-WELD"
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Kaiser Aluminum & Chemical Sales, Inc.
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Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
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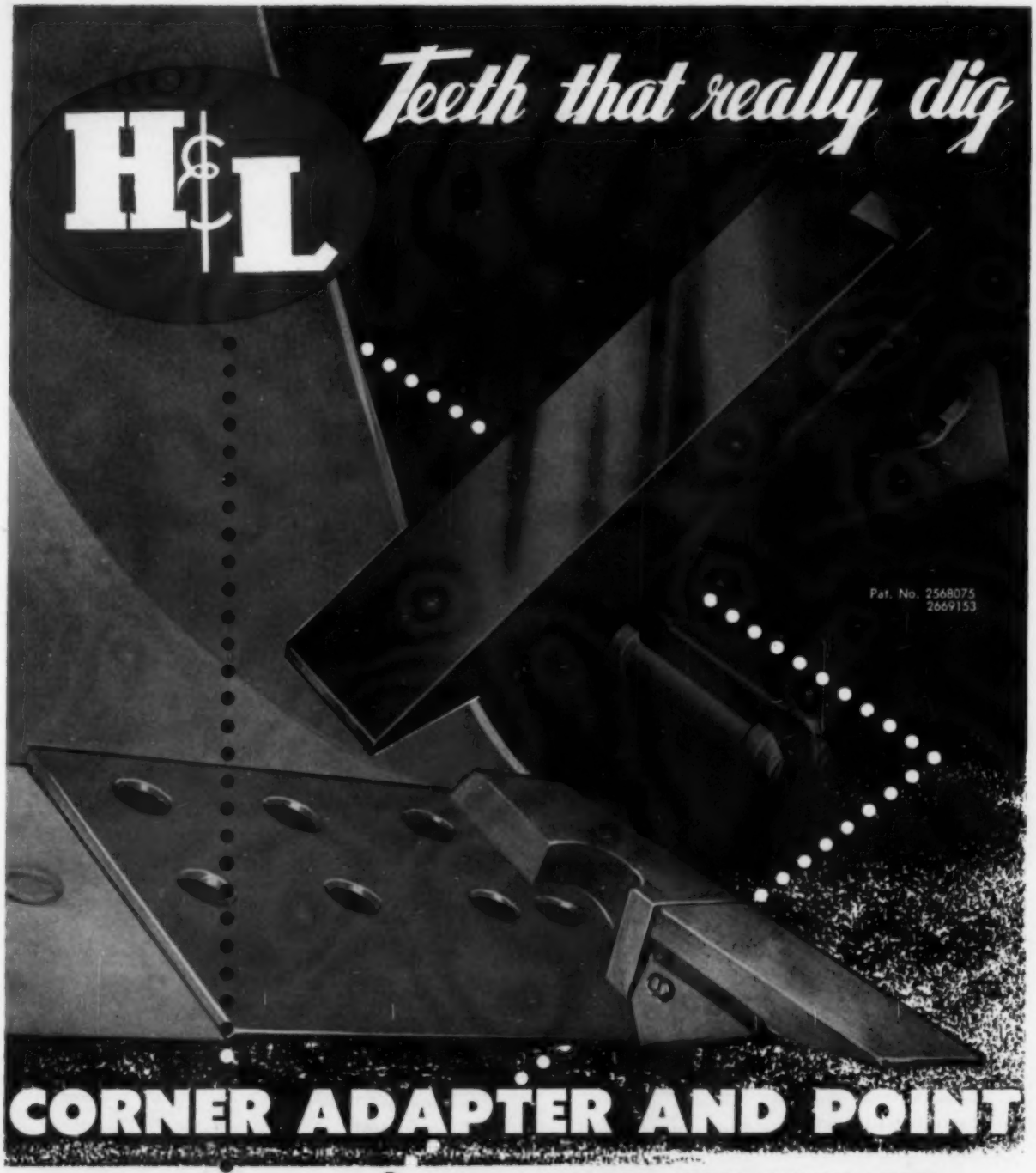

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General Electric Co., Wire and Cable Dept. Conduit Products Dept.
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Kaiser Aluminum & Chemical Sales, Inc.
Okonite Co.
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John Flocker & Co.
Flood City Brass & Electric Co.
General Cable Corp.—"SUPERSERVICE"
General Electric Co., Wire and Cable Dept., Conduit Products Dept.
Joy Mfg. Co.
Kaiser Aluminum & Chemical Sales, Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Okonite Co.
John A. Roebling's Sons Corp., Sub. of Colorado Fuel & Iron Corp.
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Ohio Brass Co.

CABLE ASSEMBLIES

Bergen Wire Rope Co.

CABLE CLAMPS

Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Holub Industries, Inc.
Ohio Brass Co.
Ore Reclamation Co.
Rome Cable Corp.

CABLE CONNECTORS, ELECTRICAL

Albert & J. M. Anderson Mfg. Co.—"EITHEREND"
Burndy Corp.—"SERVIT," "QIKLUG," "OKLIP," "KALUG," "SCRULUG," "HYLUG" "HYLINK"
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Erico Products, Inc.—"CADWELD"
Ensign Electric & Mfg. Co.
Guyan Machy. Co.
Joy Mfg. Co.
Magnetic Engrg. & Mfg. Co.
Mosebach Electric & Supply Co.
National Electric Products Co.
Ohio Brass Co.
Tweco Products, Inc.—"SOLCON," "MECCON"
West Virginia Armature Co.

CABLE CONTROLS

Caterpillar Tractor Co.
Rome Cable Corp.

CABLE COUPLERS

PLM Products, Inc. (7,500 V)

CABLE FAULT-FINDERS, PROOF TESTERS

The Electrical Distributors Co.
General Equipment & Manufacturing Co.

CABLE HANGERS

American Mine Supply Co.
Ohio Brass Co.
Rome Cable Corp.

CABLE PROTECTORS

Standard Devices Co.

CABLE REELS, LOCOMOTIVE

Jeffrey Mfg. Co.
West Virginia Armature Co.

CABLE REELS, MINING-MACHINE, SHUTTLE CAR

Dooley Brothers
Jeffrey Mfg. Co.

CABLE REELS, SHOTFIRING

J. V. Hammond Co.

CABLE-REPAIR SERVICE

Cable Vulcanizing Shop, Inc.

CABLE SPLICERS

American Mine Door Co.—"QUICK-ON"
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Ensign Electric & Mfg. Co.
Erico Products, Inc.—"CADWELD"
Flood City Brass & Electric Co.
G & W Electric Specialty Co.
Mine Safety Appliances Co.—"VELOCITY-POWER"
Minnesota Mining & Mfg. Co.—"SCOTCHCAST"
Mosebach Electric & Supply Co.
National Mine Service Co.
Ohio Brass Co.
Tweco Products, Inc.—"TWECO"
West Virginia Armature Co.

CABLE-SPLICING KITS

PLM Products, Inc.

CABLE SUPPORTS

Delta-Star Electric Div., H. K. Porter Co., Inc.

CABLE SUPPORTS, BOREHOLE

Ohio Brass Co.

CABLE SUPPORTS, HORIZONTAL RUNS

The Elreco Corp.—"ELRECO"
Ohio Brass Co.
Rome Cable Corp.

CABLE VULCANIZERS

American Mine Door Co.—"SHALER"
Flood City Brass & Electric Co.
Joy Mfg. Co.
Mine Safety Appliances Co.

CABLEWAYS

Rome Cable Corp.

CAGERS, CAGING EQUIPMENT

C. S Card Iron Works
Connellsville Mfg. & Mine Supply Co.
Robert Holmes & Bros, Inc.
The Nolan Co.
Robert & Schaefer Co., Div., Thompson-Starrett Co., Inc.

CAGES

C. S. Card Iron Works
Connellsville Mfg. & Mine Supply Co.
Helmick Foundry-Machine Co.
Robert Holmes & Bros., Inc.
Kanawha Mfg. Co.
May Tunnel & Mine Equipment
Roberts & Schaefer Co., Div., Thompson-Starrett Co., Inc.
Vulcan Iron Works

CAGES, ELEVATOR-TYPE

Connellsville Mfg. & Mine Supplu Co.—"PORTAL-CAGE"
Helmick Foundry-Machine Co.
Robert Holmes & Bros., Inc.

CAGES, PLATFORM

The Nolan Co.

CAGES, SELF-DUMPING

The Nolan Co.

CALCIUM CHLORIDE

Columbia-Southern Chemical Corp.
The Dow Chemical Co.—"DOW-FLAKE," "PELADOW"
E. I. du Pont de Nemours & Co., Inc.
Fisher Scientific Co.
Fuel Process Co.—"FUPROCO"
Solvay Process Div., Allied Chemical Corp.
Wyandotte Chemicals Corp., Michigan Alkali Div.

CAPACITORS

Cornell-Dubilier Electric Corp.
General Electric Co., Apparatus Sales Div.
Ohio Brass Co.—"VAREY"
Westinghouse Electric Corp.

CAP HATS

Mine Safety Appliances Co.—"FIXED CROWN"

CAP-LAMP CHARGERS

Mine Safety Appliances Co.
National Mine Service Co.

CAP-LAMP RACKS

Mine Safety Appliances Co.
National Mine Service Co.

CAP LAMPS

Mine Safety Appliances Co.—"EDISON R4" "EDISON MODEL S"
National Mine Service Co.

CAPS, MINERS

E. D. Bullard Co.

CAR BY-PASSERS

American Mine Door Co.—"CANTON"

CAR DUMPERS

Link-Belt Co., Dept. CAMGL-59—"KAR-FLO"

CAR DUMPERS, R. R. ROTARY

Differential Steel Car Co.
Heyl & Patterson, Inc.
Link-Belt Co., Dept. CAMGL-59—"LINK-BELT"
Roberts & Schaefer Co., Div., Thompson-Starrett Co., Inc.
Vulcan Iron Works

CAR HAULS, MINE

Link-Belt Co., Dept. CAMGL-59
The Nolan Co.

CAR HAULS, MOVERS, PULLERS, R. R.

The Aldon Co.
Advance Car Mover Co., Inc.—"BADGER," "NEW BADGER," "POWER KING," "POWER BOY"
Gibraltar Equipment & Mfg. Co.
Hewitt-Robins Incorporated—"JONES"
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-59—"LINK-BELT"
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Roberts & Schaefer Co., Div., Thompson-Starrett Co., Inc.
Webster Mfg. Inc.
Whiting Corp.

CAR HAULS, MOVERS, SPOTTERS, MINE

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Connellsville Mfg. & Mine Supply Co.
Flood City Brass & Electric Co.
Gibraltar Equipment & Mfg. Co.
Hewitt-Robins Incorporated
Robert Holmes & Bros., Inc.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-59—"LINK-BELT"
Morse Bros. Machinery Co.
B. J. Nykerk Corp.—"HAUSHERR"
Sanford Day Iron Works, Inc.
Schroeder Brothers Corp.
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.
Webster Mfg. Inc.
Wilmot Engineering Co.

CAR HAULS, MOVERS, SPOTTERS, MINE, HYDRAULIC

The Nolan Co.
Sanford Day Iron Works, Inc.
W. R. Stamler Corp.

CAR HOLDS, STOPS, MINE

C. S. Card Iron Works
Connellsville Mfg. & Mine Supply Co.
Duquesne Mine Supply Co.
Robert Holmes & Bros., Inc.
Irwin-Sensenich Corp.
Kanawha Mfg. Co.
The Nolan Co.

12 ways to coin money with "Canton" MINING EQUIPMENT

Canton Automatic Mine Doors

The Automatic Door operates mechanically by weight of car on actuating levers. Air power operation may be had where desirable. Operates at any trip speed. Two doors provide air lock.

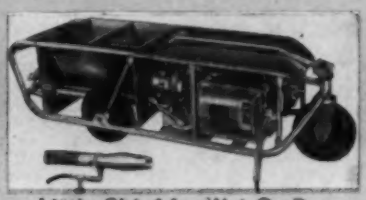
Air Power Car Transfer

One man does the work of three and faster. Entire train loaded out on a single track. Expedites servicing cars to mucking machine.

Modernize The Cost-Less Way for QUICKER PROFITS

Manually Operated Car Transfer

No alterations to track—quickly installed and relocated—less rib to shoot than for lump switch—no hazards of cherry picker, antifriction bearings for easy hand operation.

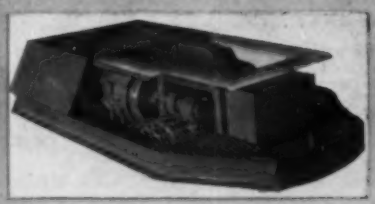


Little Chief for Wet Or Dry Dusting

Rubber tire model 22½" high—skid model 18½" high for shuttle buggies, belts or mine cars; track mounted for haulage roads. 34 to 60 lbs. dust per minute through 50 to 250 ft. of 2" hose.

Little Chief Self Propelled Rock Duster

Hydraulically driven from a gear type pump directly connected to dusting motor. Travels up to 2 miles per hour. Wet or dry dusting. Height on tires 23½". Turning radius, its own length.



Dustmaster

The track mounted Hi-pressure "Dustmaster" is the most powerful Duster ever built. Distributes dust to back areas 500 feet from haulway.

Mighty Midget Duster

Weighs only 280 lbs. Easily moved on shuttle car. Hand cart available. Ideal for small mines—inexpensive—capacity 7 tons dust per shift.

Track Cleaner

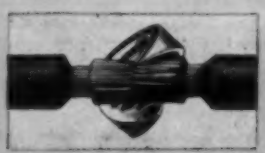
Clean entire track area mechanically in one pass—no costly hand labor, no dozers or loaders required—hydraulic controls throughout. "Pays for itself in one sweep through mine. "Now used in coal — iron — copper—lead—potash and salt mines.

Track Switch Thrower

Either electric or air operated. Route selections made by motorman at full trip speeds. Eliminates accident potential and extra man. Also ideal as Derailer. Manual or automatic contractors available.

Cable Vulcanizer

Restores insulation to original condition. Used with Canton splicers makes splice strong as original cable.



Canton Cable Splicers

Reduce down-time in splicing cable. Machine man should carry a pocketful. Just pound around cable as shown and keep on working. No special tools.

Remember you can install a "Canton" now and pay us out of savings. Write for complete brochures. Please use street and zone numbers.

Half Century of Dependable Service

The American Mine Door Company

2057 Dueber Ave. Canton 6, Ohio

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Link-Belt Co., Dept. CAMGL-59

CAR MOVERS
Gilbraltar Equipment & Mfg. Co. —"GEMCO TRU-BLUE," "NEW RICHTAL," "NEW SUPERIOR"
Link-Belt Co., Dept. CAMGL-59

CAR PASSERS
Mayo Tunnel & Mine Equipment

CAR PULLERS
Clyde Iron Works, Inc.
Link-Belt Co., Dept. CAMGL-59
Shepard Niles Crane & Hoist Corp.

CAR PULLERS, R. R.
American Engineering Co.— "LOHED"
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-59

CAR RETARDERS, MINE CAR
Connellsville Mfg. & Mine Supply Co.
Fairmont Machinery Co.
Robert Holmes & Bros., Inc.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-59 "LINK-BELT"
The Nolan Co.
B. J. Nykerk Corp.—"HAUSHERR"
Sanford Day Iron Works, Inc.
Webster Mfg. Inc.

CAR RETARDERS, R. R.
Robert Holmes & Bros., Inc.
Link-Belt Co., Dept. CAMGL-59
McNally-Pittsburg Mfg. Corp.
Union Switch & Signal Div. of Westinghouse Air Brake Co.
Webster Mfg. Inc.

CAR SHAKERS, R. R.
Allis-Chalmers Mfg. Co.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-59 "LINK-BELT"
Simplicity Engineering Co.
Stephens-Adamson Mfg. Co.— "CARQUAKE"
Webster Mfg. Inc.

CAR SPOTTERS
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-59

CAR SPOTTERS, MINE
The Nolan Co.—"PORTA-FEEDER"

CAR STOPS
The Aldon Co.
Gibraltar Equipment & Mfg. Co. —"GEMCO TRU-BLUE"
The Nolan Co.

CAR STOPS, ELECTRIC
Cheatham Elec. Switching Device Co.
General Equipment & Manufacturing Co.

CAR THAWERS
Hauck Mfg. Co.
Hewitt Robins Incorporated

CAR THAWERS, THAWING PITS, INFRA-RED PANELS
Hauck Mfg. Co.

CAR TRANSFERS, MINE
American Mine Door Co.— "CANTON"
C. S. Card Iron Works
Connellsville Mfg. & Mine Supply Co.

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Allegheny Ludlum Steel Corp.— "CARMET"

CARBON BLACK
Fisher Scientific Co.
R. T. Vanderbilt Co. Inc.

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Enterprise Wheel & Car Corp.
Irwin-Sensenich Corp.

CARRIERS, SHUTTLE-CAR
Salem-Brosius, Inc.—"PHILDOLLY"

CARS, BALLAST
Differential Steel Car Co.

CARS, RAIL, AIR-DUMP
C. S. Card Iron Works
Differential Steel Car Co.

CARS, RAIL, MAN TRIP
Bethlehem Steel Co.
C. S. Card Iron works
Differential Steel Car Co.
Enterprise Wheel & Car Corp.
Robert Holmes & Bros., Inc.
Irwin-Sensenich Corp.— "MAN-VAN"
Sanford Day Iron Works, Inc.
Watt Car & Wheel Co.

CARS, RAIL, MAN-TRIP, SELF-PROPELLED
Galis Electric & Machine Co.
Lee-Norse Co.—"MINE PORTAL BUS"

CARS, RAIL, MINE
American Car & Foundry Div., ACF Industries, Inc.
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C. S. Card Iron Works
Differential Steel Car Co.
Enterprise Wheel & Car Corp.
Gibraltar Equipment & Mfg. Co.
Helmick Foundry-Machine Co.
Hockensmith Corp.
Irwin-Sensenich Corp.
Kanawha Mfg. Co.
Kersey Manufacturing Co., Inc.
Mayo Tunnel & Mine Equipment
Morse Bros. Machinery Co.
Sanford Day Iron Works, Inc.
United States Steel Corp.
Watt Car & Wheel Co.

CARS, RAIL, PERSONNEL, SELF-PROPELLED
Galis Electric & Machine Co.
Irwin-Sensenich Corp.
Kersey Manufacturing Co., Inc.
Lee-Norse Co.—"MINE JITNEY & MINE SCOOTER," "MINE MECHANIC JITNEY"

CARS, RAIL, SUPPLY
Bethlehem Steel Co.
C. S. Card Iron Works
Differential Steel Car Co.
Enterprise Wheel & Car Corp.
Gibraltar Equipment & Mfg. Co. —"GEMCO TRU-BLUE"
Helmick Foundry-Machine Co.
Robert Holmes & Bros., Inc.
Irwin-Sensenich Corp.
Sanford Day Iron Works, Inc.
Watt Car & Wheel Co.

CARS, RAIL, TOOL
Gibraltar Equipment & Mfg. Co.

CARS, RAIL, TOOL & REPAIR, SELF-PROPELLED
Joy Mfg. Co.

CARS, RAIL, TOOL & SUPPLIES
Kersey Manufacturing Co., Inc.

CARS, RUBBER-TIRED, COAL, SELF-PROPELLED
Joy Mfg. Co.
Kanawha Mfg. Co.
Prime Mover Co.—"M30 PRIME-MOVER"

CARS, RUBBER-TIRED, MEN & SUPPLIES, SELF-PROPELLED
Fred's Welding Service
Gilbraltar Equipment & Mfg. Co.
Joy Mfg. Co.
Lee-Norse Co.—"LEE-NORSE UTILITY TRUCK"
Prime Mover Co.—"M30 PRIME MOVER"

CARS, RUBBER-TIRED TRAILING, COAL
Fred's Welding Serivce
Goodman Mfg. Co.
Joy Mfg. Co.
Kersey Manufacturing Co., Inc.
Motor Exchange and Supply Co.

CARS, RUBBER-TIRED TRAILING, MEN & SUPPLIES
Kersey Manufacturing Co., Inc.

CARS, SHUTTLE
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Kersey Manufacturing Co., Inc.
Morse Bros. Machinery Co.
National Mine Service Co.— "TOR KAR"

CARS, SHUTTLE, AC & DC
Joy Mfg. Co.

CARS, SHUTTLE, CRAWLER-TYPE
Myers-Whaley Co.—"WHALEY TRANSFER CAR"

CARS, SHUTTLE, DIESEL
Joy Mfg. Co.

CARS, SHUTTLE REPAIR
Leman Machine Co.

CARS, SURGE
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Irwin-Sensenich Corp.
Joy Mfg. Co.

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Bearings, Inc.
Link-Belt Co., Dept. CAMGL-59

CASTINGS, ABRASION-RESISTANT
Farrell-Cheek Steel Co.
Wall Colmonoy Corp.

CASTINGS, ALLOY
Coast Metals, Inc.
Farrell-Cheek Steel Co.

CASTINGS, BRONZE
American Brake Shoe Co., National Bearing Div.

CASTINGS, CENTRIFUGAL, NONFERROUS
Stoody Co.

CASTINGS, GRAY IRON
Link-Belt Co., Dept. CAMGL-59
R. H. Sheppard Co., Inc.

CASTINGS, HEAT-, CORROSION- & ABRASION-RESISTANT
Electric Steel Foundry Co.

CASTINGS, IRON, MEEHANITE, MODULAR AND STEEL
Farrel-Birmingham Co., Inc.

CASTINGS, MALLEABLE IRON
Link-Belt Co., Dept. CAMGL-59
R. H. Sheppard Co., Inc.

CASTINGS, MANGANESE STEEL
Farrell-Cheek Steel Co.
Kensington Steel, Div. of Poor & Co.

CASTINGS, NON-FERROUS
American Crucible Prods. Co.

CASTINGS, STAINLESS STEEL
Alloy Steel Castings Co.

CASTINGS, STEEL
The Falk Corp.—"MOLLY-TELASTIC"
Farrell-Cheek Steel Co.

CAUSTIC SODA
American Minechem Co.
Columbia-Southern Chemical Corp.
The Dow Chemical Co.
E. I. du Pont de Nemours & Co., Inc.
Fisher Scientific Co.
Wyandotte Chemicals Corp., Michigan Alkali Div.

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Johns-Manville—"BLAKITE"
Mexico Refractories Co.— "BONDSET," "HILOSET," "HY-SET"
Norton Co.—"ALUNDUM," "CRYSTOLON"

CENTRIFUGES
Heyl & Patterson, Inc.— "REINEVELD"

CERAMIC COATINGS
Norton Co.—"ROKIDE"

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American Manganese Steel Div., American Brake Shoe Co.— "AMSCO"
American Chain Div., American Chain & Cable Co., Inc.
Chain Belt Co.—"REX"
Diamond Chain Co., Inc.
J. D. Christian Engineers
Continental Gin Co., Ind. Div.
The Daniels Co., Contractors, Inc.
Farrell-Cheek Steel Co.
Guyan Machy. Co.—"WILMONT," "UNION"
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Irwin-Sensenich Corp.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kensington Steel Div., of Poor & Co.
Link-Belt Co., Dept. CAMGL-59 —"LINK-BELT," "RIVETLESS," "PROMAL," "LXS"
McNally-Pittsburg Mfg. Corp.
Mining Machine Parts, Inc.
Ore Reclamation Co.
K. Prins & Associates
W. J. Savage Co.
Taylor-Wharton Co. Div. Harsco Corp.
Transall, Inc.
Watt Car & Wheel Co.
Webster Mfg. Inc.
Wilmot Engineering Co.

CHAIN, FLAT METAL
American Chain Div., American Chain & Cable Co., Inc.
Link-Belt Co., Dept. CAMGL-59

CHAIN, FLIGHT CONVEYOR & ELEVATOR
Acme Chain Corp.
Farrell-Cheek Steel Co.
Link-Belt Co., Dept. CAMGL-59
Whitney Chain Co., Sub. of Foote Bros. Gear & Machine Corp.

CHAIN, MINE CAR SAFETY
American Chain Div., American Chain & Cable Co., Inc.

CHAIN POWER-TRANSMISSION
Browning Mfg. Co.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co., Ind. Div.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.
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Kremser & Sons, Inc., Frank A.
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McNally-Pittsburg Mfg. Corp.
Mining Machine Parts, Inc.
Morse Chain Co., A Borg-Warner Industry
Transall, Inc.
Whitney Chain Co., Sub. of Foote Bros. Gear & Machine Corp.

CHAIN REPAIR LINKS
Link-Belt Co., Dept. CAMGL-59
Page Engineering Co.—"TWINPIN," "KWIK-WELD"

CHAIN, ROLLER
Acme Chain Corp.
Flood City Brass & Electric Co.
Guyan Machy. Co.— "DIAMOND"
Link-Belt Co., Dept. CAMGL-59 —"FR," "RC," "SILVERBRITE"

CHAIN, SHUTTLE CAR
Link-Belt Co., Dept. CAMGL-59
Whitney Chain Co., Sub. of Foote Bros. Gear & Machine Corp.

CHAIN, SILENT
Link-Belt Co., Dept. CAMGL-59— "SILVERSTREAK"

CHAIN, WELDED
American Chain Div., American Chain & Cable Co., Inc.
Page Engineering Co.

CHAIN, WELDLESS
American Chain Div., American Chain & Cable Co., Inc.

CHAIN FITTINGS
American Chain Div., American Chain & Cable Co., Inc.
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Farrell-Cheek Steel Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-59
Page Engineering Co.
Taylor-Wharton Co. Div. Harsco Corp.

CHAIRS, CAGE-LANDING
The Nolan Co.

CHOCKS, WHEEL, SAFETY
The Aldon Co.

CHUTES
The Daniels Co., Contractors, Inc.
Enterprise Wheel and Car Corp.
Fairmont Machinery Co.
Helmick Foundry-Machine Co.
Hendrick Mfg. Co.
Hewitt-Robins Incorporated
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Irwin-Sensenich Corp.
Kanawha Mfg. Co.

Pounded over 200 times by air hammer . . . still not cut!

Even after steady pounding with an air hammer, which delivered 80 pounds of pressure to the chisel edge, Gold Seal air hose was still intact! Think of how much you will save on costly replacements should your operator accidentally hammer Gold Seal for a few seconds . . . or a trucker dump a load of rock on it . . . or a tractor grinds over it.

A. COVER: Extremely tough, resilient rubber; resists abrasion, cutting and gouging.

B. CARCASS: Braided steel wire for maximum strength and resistance to extreme impacts. Single braid of nylon cord to insure maximum bonding of cover to carcass.

C. TUBE: Synthetic compound to insure maximum oil resistance. Won't soften or flake.

Write Dept. E. for more information.

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Serving Industry Since 1870

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Meckum Engineering, Inc.
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Remaly Mfg. Co. Inc.
Roberts & Schaefer Co., Div., Thompson-Starrett Co., Inc.
W. J. Savage Co.
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Thomas Engineering & Construction Co.
Transall Inc.
Wilmot Engineering Co.

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Helmick Foundry-Machine Co.
Robert Holmes & Bros., Inc.
Irwin-Sensenich Corp.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-59
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Co., Div., Thompson-Starrett Co., Inc.
Schroeder Brothers Corp.
Thomas Engineering & Construction Co.
Wilmot Engineering Co.

CIRCUIT-BREAKER ENCLOSURES

Circuit Protective Devices Dept., General Electric Co.

CIRCUIT BREAKERS

Cutler-Hammer Inc.—"UNIT"

CIRCUIT BREAKERS, AIR

Allis-Chalmers Mfg. Co.—"RUPTAIR"
Dooley Brothers
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.
I-T-E Circuit Breaker Co.
Joy Mfg. Co.
National Mine Service Co.
Westinghouse Electric Corp.

CIRCUIT BREAKERS, OIL

Allis-Chalmers Mfg. Co.
General Electric Co., Apparatus Sales Div.
Westinghouse Electric Corp.

CIRCUIT BREAKERS, MOLDED-CASE

Circuit Protective Devices Dept., General Electric Co.

CIRCUIT INTERRUPTORS, TRAILING CABLE

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Ohio Brass Co.—"MAGNATRIP"

CIRCULATING OIL SYSTEMS

Farval Corp.—"LUBRIVAL"

CLAMPS

B. F. Goodrich Industrial Products Co.—"PUNCHLOK"

CLAMPS, FUSE

Bussmann Mfg. Div., McGraw-Edison Co.—"BUSS"
Holub Industries, Inc.

CLAMPS, FUSE & TEST

Circuit Protective Devices Dept., General Electric Co.
Ideal Industries, Inc.
Martindale Electric Co.
Trico Fuse Mfg. Co.—"KLIPLOK"

CLAMSHELLS

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Koehring Div. of Koehring Co.
The Thew Shovel Co.— "LORAIN"
Unit Crane & Shovel Corp.

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Heyl & Patterson, Inc.
Link-Belt Co., Dept. CAMGL-59

CLARIFIERS, EFFLUENT, WASTE WATER

Link-Belt Co., Dept. CAMGL-59

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Nelson L. Davis Co.— "NELDCO"
The Deister Concentrator Co., Inc.—"CONCENCO"
Diester Machine Co.
Denver Equipment Co.— "DENVER"
Dorr-Oliver, Incorporated
Heyl & Patterson, Inc.
Kennedy Van Saun Mfg. & Eng. Corp.
Link-Belt Co., Dept. CAMGL-59
Peterson Filters & Engineering Co.
Smith Engineering Works
Roberts & Schaefer Co., Div., Thompson-Starrett Co., Inc.—"HYDROTATOR"
Western Machinery Co.—"WEMCO"
Wilmot Engineering Co.

CLASSIFIERS, MECHANICAL

Denver Equipment Co.— "DENVER"
Dorr-Oliver, Incorporated
Eagle Iron Works
Link-Belt Co., Dept. CAMGL-59
The Mine & Smelter Supply Co. —"AKINS"
Morse Bros. Machinery Co.—"TRUELINE"
Straub Mfg. Co., Inc.
Western Machinery Co.—"WEMCO"

CLEANERS, MOTOR

American Minechem Co.—"ELMO," "MACMO"

CLEANERS, STEAM

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Homestead Valve Mfg. Co.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.

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Homestead Valve Mfg. Co.

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B. F. Goodrich Industrial Products Co.
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S. K. Wellman Co.—"VELVETOUCH FERAMIC," "VELVETOUCH CERAMIC'

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CLUTCHES, AUTOMATIC

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Marland One-Way Clutch Co.
Twin Disc Clutch Co.

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CLUTCHES, FRICTION

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Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-59
Morse Chain Co., A Borg-Warner Industry—"TORQUE LIMITERS"
Twin Disc Clutch Co.

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American-Standard Industrial Div.

CLUTCHES, JAW

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CLUTCHES, MAGNETIC

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Dynamatic Div. Eaton Mfg. Co.

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Dynamatic Div., Eaton Manufacturing Co.—"DYNATORQ"

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Morse Chain Co., A Borg-Warner Industry—"CAM CLUTCHES"
Joy Mfg. Co.

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Zurn Industries, Inc., Mechanical Power Transmission Div.—"SYNCHROGEAR"

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B-I-F Industries, Inc.

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Olin-Mathieson Chemical Corp., Explosive Operations, Engery Div.—"ARMSTRONG"

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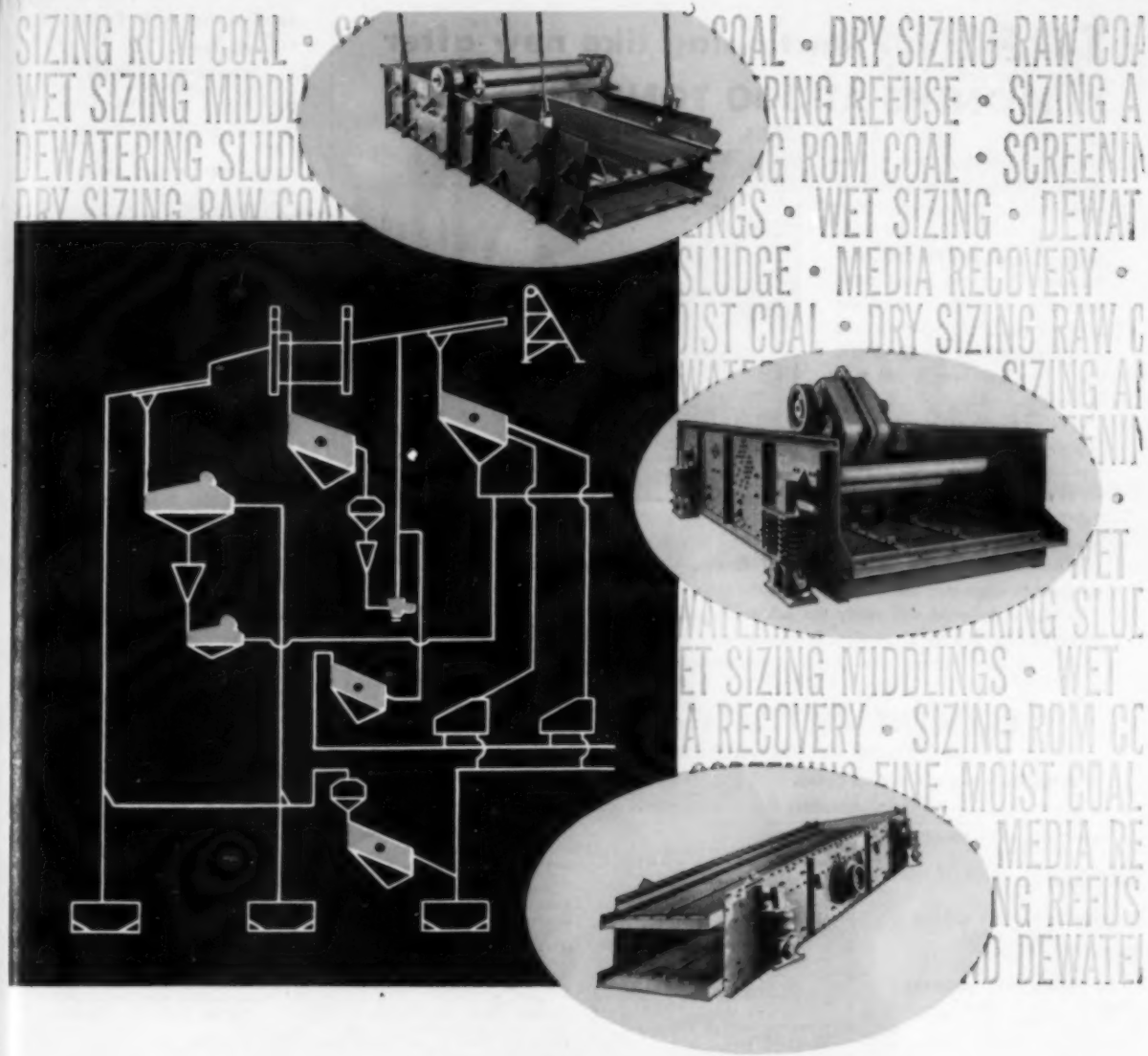

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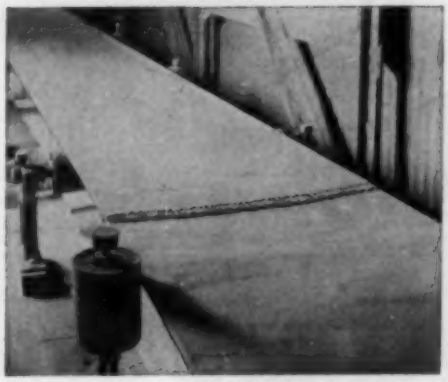

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E. F. Marsh Engrg. Co.— "MARCO"
Pioneer Engineering, Div. of Poor & Co.
McNally Pittsburg Mfg. Corp.
Thermoid Div., H. K. Porter Co., Inc.
Transall, Inc.

CONVEYOR LOADING CHECKS

Daly Ticket & Printing Co.— "DALY'S"
Thermoid Div., H. K. Porter Co., Inc.

CONVEYOR PULLEY LAGGING

General Splice Corp.—"MINET," "COLDBOND"
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-59

CONVEYOR WEIGHERS

ABC@ Scale Div., McDowell Co., Inc.—"ABC@"
B-I-F Industries, Inc.—"CONVEYELO" "PNEU-WEIGH"
Industrial Physics & Electronics Co.—"CON-O-WEIGH"
Merrick Scale Mfg. Co.— "WEIGHTOMETER"

CONVEYORS, APRON

Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co., Ind. Div.
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Link-Belt Co., Dept. CAMGL-59
Lippmann Engrg. Works Inc.
E. F. Marsh Engrg. Co.— "MARCO"
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
K. Prins & Associates
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.
Smith Engineering Works
Stephens-Adamson Mfg. Co.— "AMSCO"
Webster Mfg. Inc.

CONVEYORS, APRON, CURVE-GOING

Herold Mfg. Co.
Link-Belt Co., Dept. CAMGL-59

CONVEYORS, APRON, REPAIRS

Leman Machine Co.
Link-Belt Co., Dept. CAMGL-59

CONVEYORS, BELT

American Conveyor Co.— "CON-VAY-IT," "STOKER-VEYOR"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div. —"LIMA AUSTIN WESTERN"
Barber-Greene Co.
Baughman Mfg. Co., Inc.— "HI-SPEED"
Boston Woven Hose & Rubber Co., Div. of American Bilt-rite Rubber Co.—"BOSTON"
Carlyle Rubber Co., Inc.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div. —"WISSCO"
Compton, Inc.
Continental Gin Co., Ind. Div.
Diamond Iron Works Div. Goodman Mfg. Co.
Fairmont Machinery Co.
Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hammermills, Inc.
Herold Mfg. Co.
Hewitt-Robins Incorporated— "AJAX," "MALTESE CROSS," "MONARCH," "SUPER RAYNILE."
Heyl & Patterson, Inc.
The Homer Mfg. Div., The Ohio Electric Mfg. Co.— "HOMER"
Iowa Mfg. Co.
Irwin Sensenich Corp.
Jeffrey Mfg. Co.
Joy Mfg. Co.—LIMBEROPE," "READY-SPAN"
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Kremser & Sons, Inc., Frank A.
Link-Belt Co., Dept. CAMGL-59 "LINK BELT," "PRE-BILT"
Lippmann Engrg. Works Inc.
The Long Co.
E. F. Marsh Engrg. Co.— "MARCO"

Wilfley's "Quick-Change" FEATURES Cut DOWNTIME... MAINTENANCE COSTS

Wilfley parts can be changed in a matter of minutes — and without disturbing the intake or discharge piping. This "quick-change" — another Wilfley exclusive — is an important cost-saving advantage to economy-minded plant operators.

WILFLEY SAND PUMPS

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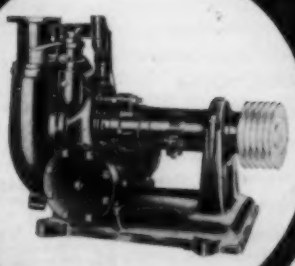
To give you maximum economy in solids pumping every Wilfley installation is JOB ENGINEERED

Write, wire or phone for complete details.



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"COMPANIONS IN ECONOMICAL OPERATION"
WILFLEY SAND PUMPS

A. R. WILFLEY and SONS, INC.

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Meckum Engineering, Inc.
Morse Bros. Machinery Co.
Ore Reclamation Co.
Pioneer Engineering, Div. of Poor & Co.
K. Prins & Associates
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.—"ZIPPER"
Thermoid Div., H. K. Porter Co. Inc.
Transall, Inc.
United States Rubber Co.
Universal Road Machinery Co.—"RELIANCE"
Webster Mfg. Inc.

CONVEYORS, BELT, EXTENSIBLE

J. D. Christian Engineers
Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins Incorporated—"MINE-AVEYORS"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-59—"PRE-BILT"
E. F. Marsh Engrg. Co.—"MARCO"
Stephens-Adamson Mfg. Co.
Webster Mfg. Inc.

CONVEYORS, BUCKET

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Baughman Mfg. Co., Inc.—"HI-SPEED"
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co. Ind. Div.
Fairmont Machinery Co.
Gallagher Co.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Link-Belt Co., Dept. CAMGL-59
Lippmann Engrg. Works Inc.
McNally-Pittsburg Mfg. Corp.
K. Prins & Associates
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Webster Mfg. Inc.
Wilmot Engineering Co.

CONVEYORS, CABLE-BELT

National Mine Service Co.

CONVEYORS, CHAIN AND BUTTON

Mining Progress, Inc.

CONVEYORS, CHAIN, CHAIN & FLIGHT

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
American Conveyor Co.—"FLIGHTVEYOR"
American Well Woks
Chain Belt Co.—"REX"
J. D. Christian Engineers
Compton, Inc.
Continental Gin Co., Ind. Div.
The Daniels Co., Contractors, Inc.
Electric Steel Foundry Co.
Electric Alloys Div., American Brake Shoe Co.
Fairmont Machinery Co.
Goodman Mfg. Co.
Helmick Foundry-Machine Co.
Irwin Sensenich Corp.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kensington Steel, Div. of Poor & Co.
Link-Belt Co., Dept. CAMGL-59
The Long Co.
McNally-Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Mining Progress, Inc.
National Mine Service Co., Clarkson Div.—"REDBIRD," "UNIFLIGHT"
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Vulcan Iron Works
Watt Car & Wheel Co.
Webster Mfg. Inc.
Wilmot Engineering Co.

CONVEYORS, CHAIN, SINGLE OR DOUBLE CHAIN & FLIGHT

Herold Mfg. Co.
Link-Belt Co. Dept. CAMGL-59
Mining Progress, Inc.

CONVEYORS, DEWATERING

Carrier Conveyor Corp.

CONVEYORS, ELEVATING

Baughman Mfg. Co., Inc.—"HI-SPEED"
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co., Ind. Div.
Fairmont Machinery Co.
Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins Incorporated
Heyl & Patterson, Inc.
Irwin Sensenich Corp.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg Co.
Link-Belt Co., Dept. CAMGL-59
Lippmann Engrg. Works Inc.
The Long Co.
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
K. Prins & Associates
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.—"REDLER," "ZIPPER"
Transall, Inc.
United States Rubber Co.
Webster Mfg. Inc.
Wilmot Engineering Co.

CONVEYORS, EXTENSIBLE CHAIN

Wilcox Mfg. Co.—"WILCOX"

CONVEYORS, MINE

Kurt Orban Co., Inc., Industrial Equipment Div.

CONVEYORS, MINE BRIDGE

Goodman Mfg. Co.
Link-Belt Co., Dept. CAMGL-59
The Long Co.—"PIGGYBACK"
E. F. Marsh Engrg. Co.—"MARCO"

CONVEYORS, MOBILE HEAD, CHAIN

The Long Co.

CONVEYORS, OSCILLATING

Link-Belt Co., Dept. CAMGL-59—"LINK-BELT," "ELE-MOUNT," "COILMOUNT," "TORQMOUNT"

CONVEYORS, PNEUMATIC

Convair

CONVEYORS, PORTABLE

American Conveyor Co.— "CONVAY-IT"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.—"LIMA AUSTIN WESTERN"
Barber-Greene Co.
Baughman Mfg. Co. Inc.—"HI-SPEED"
J. D. Christian Engineers
Goodman Mfg. Co.
Herold Mfg. Co.
Iowa Mfg. Co.
Irwin-Sensenich Corp.
Joy Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Link Belt Co., Dept. CAMGL-59
Lippmann Engrg. Works Inc.
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
Pettibone Mulliken Corp., Haiss Div.
Pioneer Engineering, Div. of Poor & Co.
Stephens-Adamson Mfg. Co.

CONVEYORS, ROPE

Goodman Mfg. Co.
Diamond Iron Works Div., Goodman Mfg. Co.
Hewitt-Robins Incorporated

CONVEYORS, ROPE & BUTTON

Fairmont Machinery Co.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.

CONVEYORS, SCREW

Baughman Mfg. Co., Inc.—"HI-SPEED"
Canton Stoker Corp.—"FLO-TUBE"
J. D. Christian Engineers—"HEVI-EDGE MANGANESE"
Continental Gin Co., Ind. Div.
Dallas Engineers Inc., Coal-O-Matic Div.—"ANTHRA-FLO,"
Dayton Automatic Stoker Co.
Jeffrey Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Link-Belt Co., Dept. CAMGL-59—"QUIK-LINK"
McNally-Pittsburg Mfg. Corp.
Ore Relamation Co.
K. Prins & Associates
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Sprout, Waldron & Co., Inc.
Stephens-Adamson Mfg. Co.
Webster Mfg. Inc.

CONVEYORS, SELF-LOADING, MINE

Herold Mfg. Co.
Link-Belt Co., Dept. CAMGL-59

CONVEYORS, SHAKING, MINE

Goodman Mfg. Co.
Herold Mfg. Co.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-59
Vulcan Iron Works

CONVEYORS, SHAKING, VIBRATING

Ajax Flexible Coupling Co., Inc.—"AJAX LO-VEYOR"
Carrier Conveyor Corp.—"CARRIER NATURAL FREQUENCY"
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Lecco Machinery & Engineering Co.—"LECCO VIB"
Link-Belt Co., Dept. CAMBL-59—"LINK-BELT," "FLEX-MOUNT," "COILMOUNT," "TORQMOUNT"
Stephens-Adamson Mfg. Co.
Syntron Co.—"VIBRA-FLOW"

CONVEYORS, SPIRAL LOWERING

J. D. Christian Engineers
Robert Holmes & Bros., Inc.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-59
McNally-Pittsburg Mfg. Corp.
Thermoid Div., H. K. Porter Co., Inc.

CONVEYORS, VIBRATING

Dravo Corp.
Link-Belt Co., Dept. CAMGL-59
Simplicity Engineering Co.

COPYING EQUIPMENT

Charles Bruning Co., Inc.

COOLANT SYSTEMS

Trico Fuse Mfg. Co.—"TRICO-MIST"

CORDS, DRILL

Collyer Insulated Wire Co.
Flood City Brass & Electric Co.
General Cable Corp.
Kaiser Aluminum & Chemical Sales, Inc.
Mosebach Electric & Supply Co.
Western Insulated Wire Co.—"BRONCO 66"

CORDS, PORTABLE, ELECTRIC

Collyer Insulated Wire Co.
Cornish Wire Co., Inc.
Ensign Electric & Mfg. Co.
Flood City Brass & Electric Co.
General Cable Corp.
Kaiser Aluminum & Chemical Sales, Inc.
Okonite Co.
Rome Cable Corp.—"ROME 60," "ROME 50"
Western Insulated Wire Co.—"BRONCO 66"

COTTER PINS

American Chain Div., American Chain & Cable Co., Inc.

COUPLERS, AUTOMATIC MINE CAR

C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Irwin-Sensenich Corp.
Mayo Tunnel & Mine Equipment
National Malleable & Steel Castings Co.—"WILLISON," "SHARON 10"
Ohio Brass Co.
Utility Mine Equipment Co.
Rydin Railway Equip. Co.

COUPLERS, MINE-CAR

Utility Mine Equipment Co.

COUPLINGS

Webster Mfg., Inc.

COUPLINGS, AIR-LINE

Acme Machinery Co.
Hunt Valve Co.—"QUICK-AS-WINK"
Hose Accessories Co.
Lincoln Engrg. Co., div. of McNeil Mach. & Engrg. Co.—"FLEX-O-MATIC"
Marman Div. Aeroquip Corp.—"CONOSEAL"
McDowell Mfg. Co.—"FAST-LINE"
Schroeder Brothers Corp.

COUPLINGS, CHAIN

Acme Chain Corp.
Link-Belt Co., Dept. CAMGL-59—"RC"

COUPLINGS, CLUTCH

Link-Belt Co., Dept. CAMGL-59
Marland One-Way Clutch Co.

COUPLINGS, CONTINUOUS SLEEVE

Link-Belt Co., Dept. CAMGL-59
Zurn Industries, Inc., Mechanical Power Transmission Div.

COUPLINGS, FIRE HOSE

The Fyr-Fyter Co.
Hewitt-Robins Incorporated

COUPLINGS, FLEXIBLE

Farrel-Birmingham Co., Inc.
Link-Belt Co., Dept. CAMGL-59
McDowell Mfg. Co.

COUPLINGS, FLEXIBLE SHAFT

Ajax Flexible Coupling Co., Inc.
Browning Mfg. Co.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co., Ind. Div.
Diamond Chain Co., Inc.
Elliott Co.
The Falk Corp.—"STEELFLEX," "AIRFLEX"
Flood City Brass & Electric Co.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Koppers Co., Inc., Metal Products Div.—"FAST'S"
Link-Belt Co., Dept. CAMGL-59—"RC," "GEARED," "MC"
Morse Chain Co., A Borg-Warner Industry—"MORFLEX" (roller, silent, nylon)
Thomas Flexible Coupling Co.—"THOMAS"
Whitney Chain Co., Sub. of Foote Bros. Gear & Machine Corp.
T. B. Woods Sons Co.—"SURE FLEX"
Zurn Industries, Inc., Mechanical Power Transmission Div.—"AMERICAN-AMERIGEAR"

COUPLINGS, FLEXIBLE-SHAFT, RIGID CHAIN

Dodge Mfg. Corp.—"TAPER-LOCK"

COUPLINGS, FLUID DRIVE

Link-Belt Co., Dept. CAMGL-59
Twin Disc Clutch Co.

COUPLINGS, FLUID & HYDRAULIC LINES

Aeroquip Corp.—"SELF SEALING"
Blackhawk Mfg. Co.
Champ Industries, Inc.
Chiksan Co.
Hunt Valve Co.—"QUICK-AS-WINK"
Hose Accessories Co.
Link-Belt Co., Dept. CAMGL-59
McDowell Mfg. Co.—"FAST-LINE"
Weatherhead Co., Fort Wayne Div.

COUPLINGS, GROOVED-END PIPE

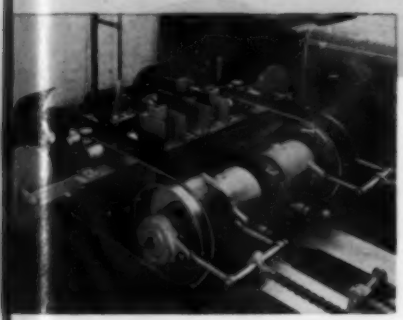
Gustin-Bacon Mfg. Co.—"GRUVAGRIP," "GRUVA-JOINT," "RIGI-GRIP," "ALUMINUM GRUVAGRIP"

COUPLINGS, HOSE

Acme Machinery Co.
Aeroquip Corp.
Anchor Coupling Co., Inc.
Carlyle Rubber Co., Inc.
Chicago Pneumatic Tool Co.
Ensign Electric & Mfg. Co.
Franklin Plastics Inc.—"DUR-X PLASTIC"
Goodall Rubber Co.
Goodyear Tire & Rubber Co.

Supreme in mining service

–for highest strength
–for lighter weight
–for longer life



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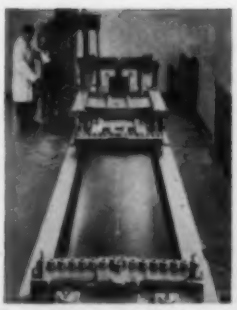

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Scandura

GOLD LINE

PVC MINE BELTING

Scandura PVC Mine Belting surpasses every standard heretofore accepted for mine conveyor belts—in the laboratory, in the mine, and in point-by-point comparison with other materials. Safe Scandura PVC (Fire Resistant U.S.B.M. 28-1) is stronger because of unique, solid-woven nylon carcass construction—lighter, more flexible, amazingly long-lived with its exclusive PVC impregnation and surface cushions. Find for yourself how superbly Scandura resists wear, mechanical damage, moisture and abuse —install a length in your present system, and compare!

Made in U.S.A.

Manufactured at CHARLOTTE, NORTH CAROLINA by SCANDINAVIA BELTING CO.

National Mine Service Company

Koppers Building Pittsburgh 19, Pa.

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ALL-STATE DIVISION Logan, W. Va. | ANTHRACITE DIVISION Forty Fort, Pa. | BEMECO DIVISION Beckley, W. Va.

KY.-VA. DIVISION Jenkins, Ky. | MOUNTAINEER DIVISION Morgantown, W. Va. | WESTERN KY. DIVISION Madisonville, Ky. | WHITEMAN DIVISION Indiana, Pa.

MANUFACTURING DIVISIONS:

ASHLAND DIVISION Ashland, Ky. | CLARKSON DIVISION Nashville, Ill. | GREENSBURG DIVISION Greensburg, Pa.

IN CANADA:

NATIONAL MINE SERVICE (CANADA) LIMITED
Elliot Lake, Ontario

Harmattan Mine coal haulers have been using STANOLUBE HD-M Motor Oil for 10 years --here's why

Pick a spot on the haulage road. Every three minutes one of the Harmattan Mine's ten 40-ton coal haulers passes the spot on the way to the preparation plant. These coal haulers have used STANOLUBE HD-M Motor Oil for ten years for these reasons:

Product: STANOLUBE HD-M Motor Oil is refined from the highest quality base stock. Blended into this carefully refined base oil are additives that retard oxidation, minimize piston ring deposit formation and prevent the forming of excessive varnish and sludge. Other additives prevent corrosion of bearing metals and eliminate bronze wrist-pin bushing corrosion.

Technical Service: Fred Barnes, who has 22 years' experience providing lubrication technical service at Standard Oil, calls on Harmattan Mine. He lives at Decatur, only

Harmattan Mine truck foreman Ralph Westfall and Standard's Fred Barnes inspect coal hauler piston. Prior to his 22 years' service providing technical assistance on lubrication problems, Fred Barnes attended James Millikin University. He has also completed the Standard Oil Sales Engineering School.

80 miles from the mine. Fred is on call at any time to get to the mine and render assistance on any problem involving lubrication engineering.

Deliveries: A Standard Oil agent located only five miles from the mine delivers lubricating oil, is handy for regular deliveries and for special deliveries at a moment's notice. The mine management never needs to worry about inventories of STANOLUBE HD-M. Their Standard Oil agent takes care of that.

Would you like this kind of service for your coal mining equipment? It's at your doorstep anywhere in the 15 Midwest or Rocky Mountain states. Call your nearby Standard Oil office. Or contact by letter, wire or telephone: **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**

One of the biggest draglines ever built is this Bucyrus-Erie unit. It is one of two in service at Harmattan Mine. Both are Standard Oil lubricated.

Every three minutes one of these 40-ton coal haulers moves down haulage road to preparation plant. STANOLUBE HD-M Motor Oil stands up to the tough service imposed on it. Dirt, adverse road conditions, hot engine operation and heavy-load—no-load service cannot lick this oil.

Quick facts about

STANOLUBE HD-M Motor Oil

- Refined from highest-quality base stock.
- Contains special additives that prevent bearing and bronze wrist-pin bushing corrosion, reduce piston ring varnish and keep rings free to seal against blow-by.
- Contains still other additives that reduce wear on heavily stressed parts.

You expect more from **STANDARD** *and you get it!*

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Hewitt-Robins Incorporated
Hunt Valve Co.—"QUICK-AS-WINK"
Hose Accessories Co.
Lincoln Engrg. Co., Div. of McNeil Mach. & Engrg. Co.—LOKTITE"
Meckum Engineering, Inc.
Schroeder Brothers Corp.
Thor Power Tool Co.
United States Rubber Co.—"EVERTITE"
Weatherhead Co., Fort Wayne Div.

COUPLINGS, HYDRAULIC

Link-Belt Co., Dept. CAMGL-59
National Supply Co.— "NATIONAL"

COUPLINGS, HYDRAULIC-DRIVE

Link-Belt Co., Dept. CAMGL-59

COUPLINGS, MAGNETIC-DRIVE

Dynamatic Div., Eaton Mfg. Co.

COUPLINGS, PLAIN END PIPE

Gustin-Bacon Mfg. Co.—"ROL-AGRIP"
Victualic Co. of America—"VICTUALIC ROUST-ABOUT"

COUPLINGS, SHAFT

Dodge Mfg. Corp.—"PARA-FLUX"
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-59

COUPLINGS, SHAFT, FLEXIBLE, RIGID, COMPRESSION CHAIN

Link-Belt Co., Dept. CAMGL-59

COUPLINGS, SWIVEL, BRONZE

The Lunkenheimer Co.—"LUNKENHEIMER"

COVERING, FLOOR, STAIR

Minnesota Mining & Mfg. Co. "SAFETY WALK"

CRANES, CRAWLER

Link-Belt Speeder Corp.
"Quick-Way" Truck Shovel Co.

CRANES, GANTRY & WALL

American Hoist & Derrick Co.

CRANES, MOBILE

American Hoist & Derrick Co. —"AMERICAN"
Austin-Western, Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Baldwin-Lima-Hamilton Corp., Construction Equipment Div. —"LIMA"
Bucyrus-Erie Co.
Clark Equipment Co., Construction Machinery Div.—"MICHIGAN"
Dravo Corp.
Gar Wood Industries, Inc.
Harnischfeger Corp.
Hyster Co.—"KARRY KRANE"
Koehring Div. of Koehring Co.
LeTourneau-Westinghouse Co. —"TOURNAPULL"
Marion Power Shovel Co., a Div. of Universal Marion Corp.
Northwest Engineering Co.
Orton Crane & Shovel Co.
Ruger Equipment, Inc.—"RUGER"
Schield Bantam Co.
The Thew Shovel Co.—"LORAIN"
Unit Crane & Shovel Corp.

CRANES, RUBBER-TIRED, SELF-PROPELLED

Link-Belt Speeder Corp.

CRANES, SHOP & PLANT

Austin-Western, Construction Equipment Div. Baldwin-Lima-Hamilton Corp.
Guyan Machy Co.
Harnischfeger Corp.
Manning Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div. —"SHAW BOX," "LOAD LIFTER"
Morse Bros. Machinery Co.
Robbins & Myers, Inc.—"R & M"
Shepard Niles Crane & Hoist Corp.

CRANES, TRACTOR

Allis-Chalmers Mfg. Co.

CRANES, TRACTOR & TRUCK

Austin-Western, Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.—"LIMA"
Clark Equipment Co., Construction Machinery Div.—"MICHIGAN"
FWD Corp.
Gar Wood Industries, Inc.
Harnischfeger Corp.
Insley Mfg. Corp.
Marion Power Shovel Co., a Div. of Universal Marion Corp.

CRANES, TRUCK

American Hoist & Derrick Co.—"AMERICAN"
Austin-Western, Construction Equipment Div. Baldwin-Lima-Hamilton Corp.
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.—"LIMA"
Bucyrus-Erie Co.
Clark Equipment Co., Construction Machinery Div.—"MICHIGAN"
FWD Corp.
Gar Wood Industries, Inc.
Harnischfeger Corp.
Insley Mfg. Corp.
Koehring Div. of Koehring Co.
Link-Belt Speeder Corp.—"SEPHYRCRANES"
Marion Power Shovel Co., a Div. of Universal Marion Corp.
Northwest Engineering Co.
Pitman Manufacturing Co.—"HYDR-A-LIFT," "PITMAN MODEL 80"
"Quick-Way" Truck Shovel Co.
Ruger Equipment, Inc.—"RUGER"
Schield Bantam Co.
The Thew Shovel Co.—"LORAIN MOTOCRANE"

CRANES, TRUCK, CHASSIS

Hendrickson Mfg. Co.

CRANES, WHIRLEY

Clyde Iron Works, Inc.

CRAWLER PADS

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Kensington Steel, Div. of Poor & Co.

CREOSOTE OIL

Republic Creosoting Co.

CRIB RELEASE BARS

Mining Progress, Inc.

CROSSING SIGNALS, RAIL, HIGHWAY

American Mine Door Co.
General Equipment & Manufacturing Co.
Nachod & U. S. Signal Co.

CRUSHER JAWS

American Manganese Steel Div. American Brake Shoe Co.—"AMSCO"
Kensington Steel, Div. of Poor & Co.

CRUSHERS, COAL

Link-Belt Co., Dept. CAMGL-59

CRUSHERS, DOUBLE-ROLL

McLanahan & Stone Corp.

CRUSHERS, HAMMER

American Pulverizer Co.
Diamond Iron Works, Div. Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hammermills, Inc.—"BULLDOG"
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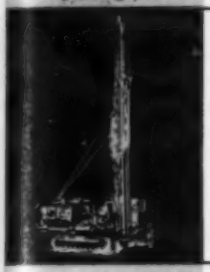

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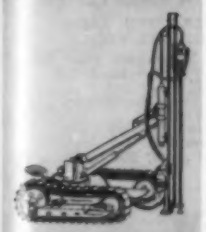

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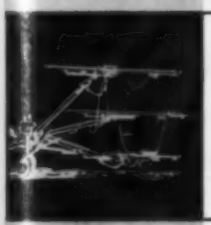

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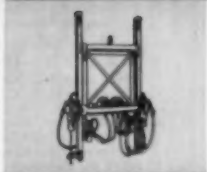

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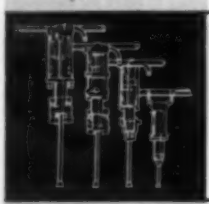

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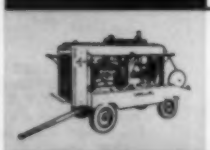

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Schroeder Brothers Corp.

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Chicago Pneumatic Tool Co.— "CP"
Jeffrey Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Penn Machine Co.
Schroeder Brothers Corp.

DRILLS, COAL, HYDRAULIC

The Long Co.

DRILLS, COAL, MOUNTED SELF-PROPELLED

Bucyrus-Erie Co.
Chicago Pneumatic Tool Co.— "CP"
Dooley Brothers
Jeffrey Mfg. Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Lee-Norse Company—"LEE-NORSE DRILL TRUCK"
Mobile Drilling, Inc.
B. J. Nykerk Corp.— "HAUSHERR"
Paris Mfg. Co.
Penn Machine Co.
The Salem Tool Co.—"Mc-CARTHY"
Stardrill-Keystone Co., Div of Koehring Co.—"SPEED STAR," "KEYSTONE-FRANKS"
Winter-Weiss Co.—PORTA-DRILL"

DRILLS, COAL, POST-MOUNTED

Chicago Pneumatic Tool Co.— "CP"
Dooley Brothers
Jeffrey Mfg. Co.
The Leetonia Tool Co.
Morse Bros. Machinery Co.
Penn Machine Co.
The Salem Tool Co.—"SALEM"

DRILLS, COAL RECOVERY

Airdox Cardox Products Co.
The Salem Tool Co.

DRILLS, COMBINATION ROTARY & DOWN THE HOLE

REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"

DRILLS, CORE

Acker Drill Co.—"HILLBILLY," "TEREDO," "PACKSACK" "MODELS LD, KR"
Chicago Pneumatic Tool Co.— "CP"
Geo. E. Failing Co., Sub. of Westinghouse Air Brake Co — "HOEMASTER"
Hoffman Brothers Drilling Co.
Joy Mfg. Co.
Mobile Drilling, Inc.
Pennsylvania Drilling Co
REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"
Sprague & Henwood Inc.
Winter Weiss Co.—"PORTA-DRILL"

DRILLS, CORE, PORTABLE

Acker Drill Co., Inc.—"ACKER PACKSACK (AIR)"

DRILLS, CRAWLER-MOUNTED

REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"
Thor Power Tool Co.

DRILLS, HIGHWAY, HORIZONTAL, AUGER

Airdox Cardox Products Co.
The Salem Tool Co.—"Mc-CARTHY"

DRILLS, MASONRY

Metallurgical Products Dept., General Electric Co.— "CARBOLOY"
Mobile Drilling, Inc.
Pennsylvania Drilling Co., Masonry Drill Div.

DRILLS, OVERBURDEN, CRAWLER & TRACTOR MOUNTED

REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"

DRILLS, OVERBURDEN DOWN-THE-HOLE

Airdox Cardox Products Co.
REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"
Schramm, Inc.—"ROTATOOL"

DRILLS, OVERBURDEN, ROTARY-PERCUSSION

Geo. E. Failing Co., Sub. of Westinghouse Air Brake Co.— "BLASTMASTER"

DRILLS, OVERBURDEN, SIDEWALL

Chicago Pneumatic Tool Co. "CP"
Geo. E. Failing Co., Sub of Westinghouse Air Brake Co.— "HD-1-HOLEMASTER"
Joy Mfg. Co
Mobile Drilling Inc.
B. J. Nykerk Corp.—"HAUSHERR"
Paris Mfg Co
REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"
The Salem Tool Co.—"Mc CARTHY"

DRILLS, OVERBURDEN, TRACTOR-MOUNTED PNEUMATIC

Chicago Pneumatic Tool Co.— "TRACDRIL"
Gardner-Denver Company
Joy Mfg. Co.—"CHALLENGER"
B. J. Nykerk Corp.— "HAUSHERR"
Schamm Inc.—"ROTADRILL ON PNEUMATRACTOR"
Winter-Weiss Co.—"PORTA-DRILL"

DRILLS, OVERBURDEN, TRACTOR-MOUNTED, ROTARY

Davey Compressor Co.

DRILLS, OVERBURDEN, VERTICAL AUGER

Airdox Cardox Products Co.
The Salem Tool Co.—"Mc-CARTHY"

DRILLS, OVERBURDEN, VERTICAL CHURN

Bucyrus-Erie Co.
Stardrill-Keystone Co., a Div. of Koehring Co.—"SPEED TAR, "KEYSTONE"

DRILLS, OVERBURDEN, VERTICAL ROTARY

Airdox Cardox Products Co.
Bucyrus-Erie Co.
Geo. E. Failing Co., Sub. of Westinghouse Air Brake Co.— "HOLEMASTER"
Joy Mfg. Co.—"CHAMPION"
Mobile Drilling Inc.
B. J. Nykerk Corp.— "HAUSHERR"
REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"
Robins Machine & Mfg. Co., Inc.
The Salem Tool Co.—"Mc-CARTHY"
Schramm, Inc.—"ROTADRILL TRUCK MOUNTED"
Stardrill-Keystone Co., div. of Koehring Co.—"KEYSTONE," "FRANKS"
Winter-Weiss Co.—"PORTA-DRILL'

DRILLS, OVERBURDEN, VERTICAL ROTARY, TRUCK MOUNTED

Davey Compressor Co.
REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"

DRILLS, PNEUMATIC

Acme Machinery Co.
Chicago Pneumatic Tool Co.— "CP"
Davey Compressor Co.— "DAVEY-HOLMAN"
Gardner-Denver Company
Ingersoll-Rand Co.—"VACU-JET"
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
B. J. Nykerk Corp.— "HAUSHERR"
Schramm, Inc.
Schroeder Brothers Corp.
Thor Power Tool Co.

DRILLS, PORTABLE ELECTRIC

Black & Decker Mfg. Co.

DRILLS, PROSPECTING

Airdox Cardox Products Co.
Hossfeld Mfg. Co.—"HOSSFELD FELD DIRECT DRIVE"
Mobile Drilling, Inc.
REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"

DRILLS, POWER-TAKE-OFF OPERATED

Airdox Cardox Products Co.
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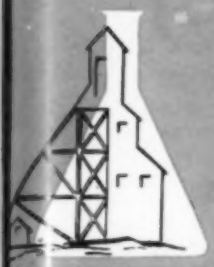

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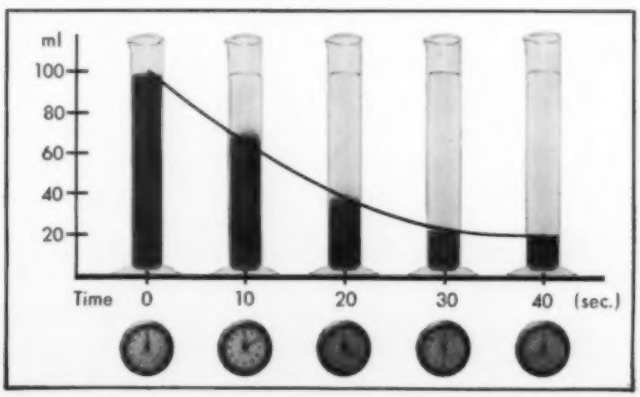

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The Salem Tool Co.—"McCARTHY"
Schramm, Inc.—"ROTADRILL on PNEUMATRACTOR"

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Penn Machine Co.
The Salem Tool Co.—"McCARTHY"

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Schroeder Brothers Corp.
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American-Standard Industrial Div.
The American Pulley Co.
Electric Machinery Mfg. Co.—"AMPLI-SPEED"
General Electric Co., Apparatus Sales Div.
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Reliance Electric & Eng Co.—"RELIANCE V-S"
Worthington Corp.

DRIVES, BELT

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Link-Belt Co., Dept. CAMGL-59
Morse Chain Co., A Borg-Warner Industry—"TIMANG"

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Chain Belt Co.—"REX"
J. D. Christian Engineers
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Diamond Chain Co., Inc.
Dodge Mfg. Corp.—"TAPER-LOCK"
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-59—"LINK-BELT," "LXS," "RIVETLESS"
Morse Chain Co., A Borg Warner Industry—"HY-VO"
National Supply Company—"NATIONAL"
Whitney Chain Co., Sub. of Foote Bros. Gear & Machine Corp.

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Barber-Greene Co.
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DRIVES, ELEVATOR

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DRIVES, FLANGE-MOUNTED

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Dodge Mfg. Corp.—"FLEXI-DYNE"
Link-Belt Co., Dept. CAMGL-59—"ELECTROFLUID"
The Master Electric Co., Div. of Reliance Electric & Eng. Co.
Twin Disc Clutch Co.

DRIVES, GEAR

The Louis Allis Co.
BlawKnox Co., Blaw-Knox Equipment Div.
The Falk Corp.
Farrel-Birmingham Co., Inc.
Foote Brothers Gear & Machinery Co.—"GEARMOTOR," "LINE-O-MOTOR," "LINE-O-MOUNT," "SHAFTMOUNT"
FWD Corp.
Hewitt-Robins Incorporated—"JONES"
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-59—"LINK-BELT," "PARALLEL," "INLINE HELICAL," "WORM"
The Master Electric Co., Div. of Reliance Electric & Eng. Co.
Pittsburgh Gear Co.
Reliance Elec. & Eng. Co.
U. S. Electrical Motors, Inc.—"SYNCRO-GEAR"

DRIVES, HYDRAULIC

Vickers Incorporated

DRIVES, ROLLER CHAIN

Link-Belt Co., Dept. CAMGL-59 "FR," "RC," "SILVERBRITE"
Morse Chain Co., A Borg-Warner Industry

DRIVES, SELECTIVE-SPEED

Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-59

DRIVES, SHAFT—MOUNTED

The Falk Corp.
Hewitt-Robins Incorporated
Link-Belt Co.— "LINK-BELT"

DRIVES, SILENT CHAIN

Link-Belt Co., Dept. CAMGL-59—"SILVERSTREAK"
Morse Chain Co., A Borg-Warner Industry

DRIVES, V-BELT

Allis-Chalmers Mfg. Co.—"TEX-OPE"
The American Pulley Co.
J. D Christian Engineers
Dayton Industrial Products Co.
Dodge Mfg. Corp.—"DYNA-V"
Flood City Brass & Electric Co.
The Gates Rubber Co. Sales Div., Inc.
Guyan Machy Co.
Hewitt-Robins Incorporated
Industrial Rubber Products Co. (W. Va.)
Iowa Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-59
Ore Reclamation Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.—"POLY-V"
Stephens-Adamson Mfg. Co.
Thermoid Co.
Worthington Corp.

DRIVES, VARIABLE-SPEED

Allis-Chalmers Mfg. Co.—"VARI-PITCH"
The Louis Allis Co.
The American Pulley Co.
J. D. Christian Engineers
Clark Controller Co.
Cleveland Worm & Gear Co.—"VARIATOR"
Dodge Mfg. Corp.
Dynamatic Div., Eaton Mfg. Co. "AJUSTO-SPEDE," "DYNASPEDE"
Foote Brothers Gear & Machinery Corp.—"VARI-MOUNT"
General Electric Co., Apparatus Sales Div.
Hewitt-Robins Incorporated
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-59—"P. I. V." "R. S. P. I. V."
Manheim Mfg. & Belting Co.—"MVS"
The Master Electric Co., Div. of Reliance Electric & Eng. Co.
Reeves Pulley Co. Div., The Reliance Electric & Engineering Co.—"VARI-SPEED"
Reliance Electric & Eng. Co.—"RELIANCE V—S"
Sterling Electric Motors, Inc.—"STERLING SPEED-TROL"
U.S. Electrical Motors, Inc.—"VARI-DRIVE"
Worthington Corp.

DRIVES, VARIABLE-SPEED EDDY-CURRENT

The Louis Allis Co.
Dynamatic Div., Eaton Mfg. Co. —"AJUSTO-SPEDE," "DYNASPEDE"
Hewitt-Robins Incorporated
Kanawha Mfg. Co.

DRIVES, VARIABLE-SPEED, HYDRAULIC

American Engineering Co.—"HELE-SHAW"
Link Belt Co., Dept. CAMGL-59

DRIVES, WORM-GEAR

Cleveland Worm & Gear Co.—"CLEVELAND"
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-59—"UNIVERSAL"

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Goodman Mfg. Co.

DUCKBILL LOADING HEADS, REBUILT

Leman Machine Co.

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Armco Drainage & Metal Prod., Inc.
Flexaust Co.—"FLEXAUST"
Kanawha Mfg. Co.
McNally-Pittsburg Mfg. Corp.

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I-T-E Circuit Breaker Co.
National Electric Products Co.
Revere Copper & Brass, Inc.
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DUCT, CABLE, ELECTRICAL

Flexaust Co.—"PLICA"
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C. S. Card Iron Works
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The Nolan Co.

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McNally-Pittsburg Mfg. Corp.
The Nolan Co.
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.

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Bemis Bro. Bag Co.

DUST COLLECTORS

Hagan Chemicals & Controls, Inc. —"HAGAN AEROSTATIC"

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Pangborn Corp.

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DUST COLLECTORS, MECHANICAL

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The Fly Ash Arrestor Corp.

DUST COLLECTORS, MECHANICAL, COAL HANDLING, PREPARATION

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American-Standard Industrial Div.
The Ducon Co., Inc.
Joy Mfg. Co.—"JOY-MICRODYNE"
Kanawha Mfg. Co.
Koppers Co., Inc., Metal Products Div.
Majac, Inc., Sub. of Blackstone Corp.
McNally-Pittsburg Mfg. Corp.
Pangborn Corp.
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.
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Wheelabrator Corp.—"DUSTUBE"

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American Air Filter Co. Inc.
The Ducon Co., Inc.
J. H. Fletcher & Co.
Mine Safety Appliances Co.—"DRILDUST BUCKET" "THRU-STEEL"
Schroeder Brothers Corp.

DUST COLLECTORS, VACUUM

Acme Machinery Co.
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.

DUST COLLECTORS, WET TYPE

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DUST CONTROL SYSTEMS

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The Johnson-March Corp.—"VERTICONE"

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DUST-EXCLUDER BOOTS

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DUST SAMPLERS

Fisher Scientific Co.
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Pierce Management Inc.
Read Davis
Robinson & Robinson
Paul Weir Co., Inc.
J. W. Woomer & Associates

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Baton & Co., Geo. S.
Commercial Testing & Engineering Co.
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Eavenson Auchmuty & Greenwald
Fairmont Machinery Co.
Fuel Process Co.
Heyl & Patterson, Inc.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-59
McNally-Pittsburg Mfg. Corp.
Meissner Engineers, Inc.
Pierce Management Inc.
K. Prins & Associates
Roberts & Schaefer Co., Div. Thompson-Starrett Co. Inc.
Robinson & Robinson
Templeton-Matthews Corp.
Paul Weir Co., Inc.

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Baton & Co., Geo. S.
Eavenson, Auchmuty & Greenwald
Pierce Management Inc.

ENGINEERS, MINE MANAGEMENT
Pierce Management Inc.

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Allis-Chalmers Mfg. Co.

ENGINES, DIESEL
Allis-Chalmers Mfg. Co.
American Marc, Inc. (7 to 16 hp)
Caterpillar Tractor Co.
Chicago Pneumatic Tool Co.
Compton Inc.
Continental Motors Corp.
Cummins Engine Co., Inc.—"CUMMINS TURBODIESEL"
GM Diesel, Detroit Diesel Engine Div., General Motors Corp.
Diesel Energy Corp.
Harnischfeger Corp.
Hercules Motor Corp.
International Harvester Co. Construction Equipment Div.
Murphy Diesel Co.
Nordberg Mfg. Co.
The Oliver Corp.—"OLIVER"
Page Engineering Co.
R. H. Sheppard Co., Inc.
Waukesha Motor Co.
White Diesel Engine Div. The White Motor Co.—"WHITE SUPERIOR"
Worthington Corp.

ENGINES, DIESEL AUTOMOTIVE
Allis-Chalmers Mfg. Co.
Continental Motors Corp.
GM Diesel, Detroit Diesel Engine Div, General Motors Corp.
Hercules Motor Corp.
Waukesha Motor Co.

ENGINES, DIESEL, MINE-LOCOMOTIVE
Hercules Motor Corp.

ENGINES, DUAL-FUEL
Allis-Chalmers Mfg. Co.
Chicago Pneumatic Tool Co.
International Harvester Co., Construction Equipment Div.
Murphy Diesel Co.
Nordberg Mfg. Co.—"DUA-FUEL"
White Diesel Engine Div., The White Motor Co.—"WHITE SUPERIOR"
Worthington Corp.

ENGINES, DUAL-FUEL, AIR COOLED
Wisconsin Motor Corp.

ENGINES, GASOLINE
Allis-Chalmers Mfg. Co.
Cities Service Oil Co.
Continental Motors Corp
Ford Div. of Ford Motor Co.
Hercules Motor Corp.
International Harvester Co., Construction Equipment Div.
The Oliver Corp.—"OLIVER"
Reo Div., The White Motor Co.
Waukesha Motor Co.

ENGINES, GASOLINE, AIR COOLED
Wisconsin Motor Corp.

ENGINES, GASOLINE AUTOMOTIVE
Allis-Chalmers Mfg. Co
Continental Motors Corp.
Ford Div. of Ford Motor Co.
Hercules Motor Corp.
International Harvester Co., Construction Equipment Div.
Waukesha Motor Co.

ENGINES, NATURAL GAS
Allis-Chalmers Mfg. Co.
American Marc Inc. (2-cyl, 15-hp)

ENGINES, OIL
Allis-Chalmers Mfg. Co.
Cities Service Oil Co.
Hercules Motor Corp.
Nordberg Mfg. Co.
Waukesha Motor Co.
White Diesel Engine Div, The White Motor Co.—"WHITE SUPERIOR"
Worthington Corp.

ENGINES, UNATTENDED, SAFETY PANELS
Stewart Warner Corp., Alemite Div.

ETCHERS, ELECTRIC
Martindale Electric Co.

EXCAVATORS, MINING
Harnischfeger Corp.

EXHAUST OR FUME STACKS
The Neff and Fry Co.

EXHAUST GAS CONDITIONERS
National Mine Service Co.

EXHAUSTERS
American-Standard Industrial Div.
Buffalo Forge Co.—"BUFFALO"
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McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Robinson Ventilating Co.
Roots-Connersville Blower Div, Dresser Industries, Inc.

EXPANSION JOINTS, BELLOWS
Tube Turns, Div. of Chemetron Corp.

EXPANSION PLUGS, ROOF-BOLTING
National Mine Service Co.
Ohio Brass Co.

EXPLORATION EQUIPMENT
Mobile Drilling Inc.

EXPLOSIVES — See also Coal Breakers; Blasting Agents; Explosives, Liquid Oxygen Type

EXPLOSIVES, COAL
American Cyanamid Co., Explosives and Mining Chemicals Dept.—"AMERICAN," "BLACK DIAMOND"
Atlas Powder Co.—"COALITE" "GELCOALITE" "KOLMITE"
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc.—"GELOBEL," "DUO-BEL®" "MONOBEL®" "LUMP COAL®"
Hercules Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.

EXPLOSIVES, LIQUID-OXYGEN TYPE
Airmite-Midwest, Inc.

EXPLOSIVES LOADING & TAMPING MACHINE, HORIZONTAL
Olin Mathieson Chemical Corp., Explosives Operations, Energy Div.

EXPLOSIVES PACKAGING, PLASTIC
Visking Co., Plastics Div. — "VIS QUEEN"

EXPLOSIVES, ROCK
American Cyanamid Co., Explosives and Mining Chemicals Dept.—"AJAX," "POWER-TOL" "FREE FLO," "CYADYN"
Atlas Powder Co.—"APEX," "AMODYN," "GIANT GELATIN" "AMOCORE," SUPERGEL" primer, GIANT 75" primer
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div. "RED CROSS®" "EXTRA®," "GELEX®"
Hercules Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.

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EYEBOLTS
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American Optical Co., Safety Products Div.
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General Scientific Equipment Co.—"GS"
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Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
United States Safety Service Co.—"SAFI-I-SHIELD," "SAFI-I-FLEX." "AIR-FLOW" "SAF-I-CHEM"

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The Falk Corp.
Flood City Brass & Electric Co.
Galigher Co.
Robert Holmes & Bros., Inc.
Irwin-Sensenich Corp.
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Leman Machine Co.
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Meckum Engineering, Inc.
Ore Reclamation Co.
W. J. Savage Co.
Simplicity Engineering Co.
Vulcan Iron Works

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Koven Fabricators, Inc.

FABRICATORS, STEEL & STRUCTURES
Arrowhead Engineers and Constructors, Inc.
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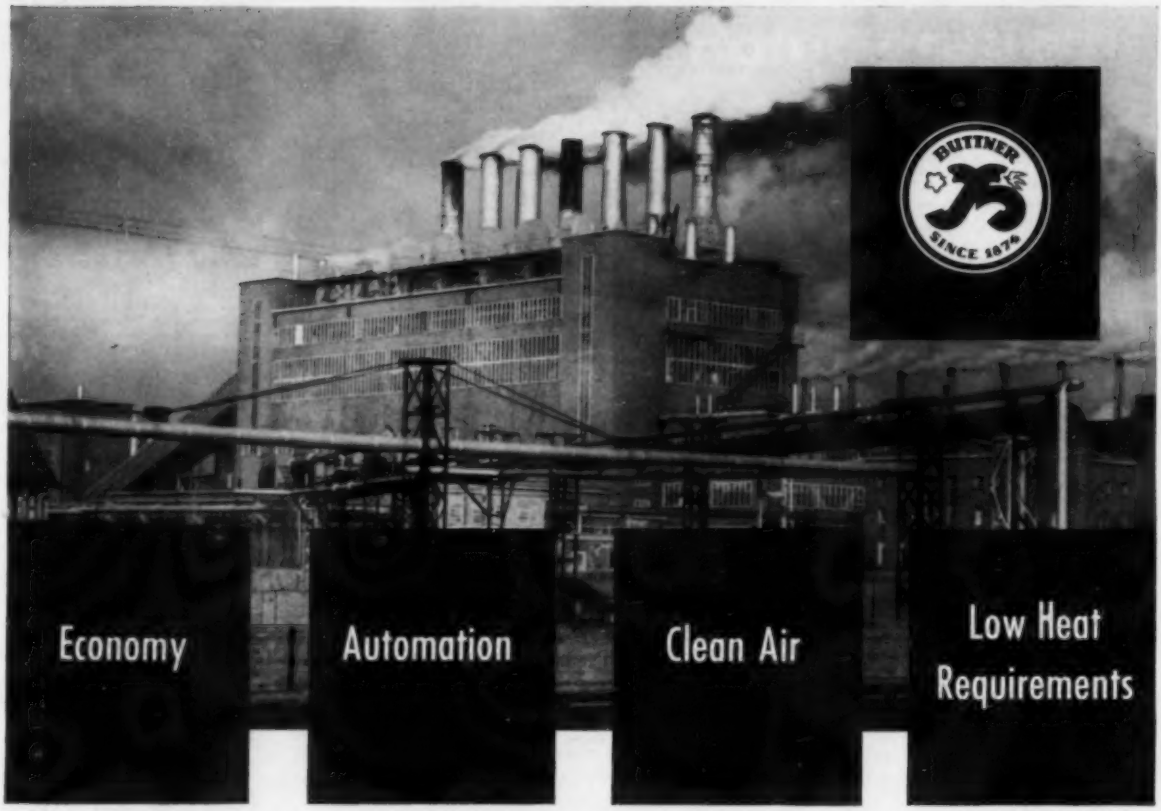

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Clarage Fan Co.
Coppus Engineering Corp.— "VANO," "VENTAIR"
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The Nolan Co.

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Merrick Scale Mfg. Co.—"FEEDOWEIGHT"
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Link-Belt Co., Dept. CAMGL-59

FEEDERS, MANGANESE

Continental Gin Co., Ind. Div.
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Fairmont Machinery Co.
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Gruendler Crusher & Pulverizer Co.
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Jeffrey Mfg. Co.
Kanawha Mfg. Co.
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Link-Belt Co., Dept. CAMGL-59

FEEDERS, ROTARY TABLE

Link-Belt Co., Dept. CAMGL-59

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Eries Mfg. Co.
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Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Lecco Machinery & Engineering Co.
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Link-Belt Co., Dept. CAMGL-59.

FLANGED MOUNTINGS, ANTI-FRICTION BEARING

Link-Belt Co., Dept. CAMGL-59
SKF Industries, Inc.

FLASHLIGHTS, SAFETY & INDUSTRIAL

General Scientific Equipment Co.—"GS"
Mine Safety Appliances Co.

FLEXIBLE SHAFT MACHINES, GRINDING

Martindale Electric Co.

FLIGHTS, CONVEYOR LINE

Link-Belt Co., Dept. CAMGL-59
Remaly Mfg. Co., Inc.

FLOAT & SINK TEST SOLUTIONS

American Minechem Co.—"CERTIGRAV"

FLOAT & SINK TESTERS

Commercial Testing & Engineering Co.
The Daniels Co., Contractors, Inc.
Robert Holmes & Bros., Inc.
REICHdrill Div., Chicago Pneumatic Tool Co. "DELATESTER," "REICHdrill"

FLOCCULATING AGENTS

American Cyanamid Co., Explosives and Mining Chemicals Dept.—"AEROFLOC®"
American Minechem Co.—"MINEFLOC"
Denver Equipment Co.
B. F. Goodrich Chemical Co.—"GOOD-RITE K-720"
Hercules Powder Co.
Hodag Chemical Corp.

FLOODLIGHTS

Crouse-Hinds Co.
General Electric Co., Lamp Div.—"GENERAL ELECTRIC"
Homelite, a div. of Textron, Inc.—"HOMELITE"
National Mine Service Co.
Phoenix Products Co., Inc.—"STURDILITE"
Westinghouse Electric Corp.

FLOODLIGHTS, PORTABLE

Mine Safety Appliances Co.

FLOOR PLATE

United States Steel Corp.—"USS MULTIGRIP"

FLOOR RESURFACES

Stonhard Co. Inc.—"STONPACH," "STONCAP," "STONHARD RESURFACER"

FLOORING, OPEN STEEL

Blaw-Knox Co., Blaw-Knox Equipment Div.

FLOORING, WOOD BLOCK

Republic Creosoting Co.

FLOTATION CONDITIONERS

American Minechem Co.
The Daniels Co., Contractors, Inc.
Denver Equipment Co.—"DENVER"
Morse Bros. Machinery Co.
Western Machinery Co.—"WEMCO FAGERGREN"

FLOTATION FROTHERS

American Cyanamid Co., Explosives and Mining Chemicals Dept.—"AEROFROTH®"
Denver Equipment Co.—"DENVER SUB-A"
Galigher Co.—"AGITAIR"

FLOTATION LAB MACHINES

Denver Equipment Co.—"DENVER SUB-A"
Galigher Co.—"AGITAIR"
Morse Bros. Machinery Co.
Western Machinery Co.—"WEMCO FAGERGREN"

FLOTATION MACHINES

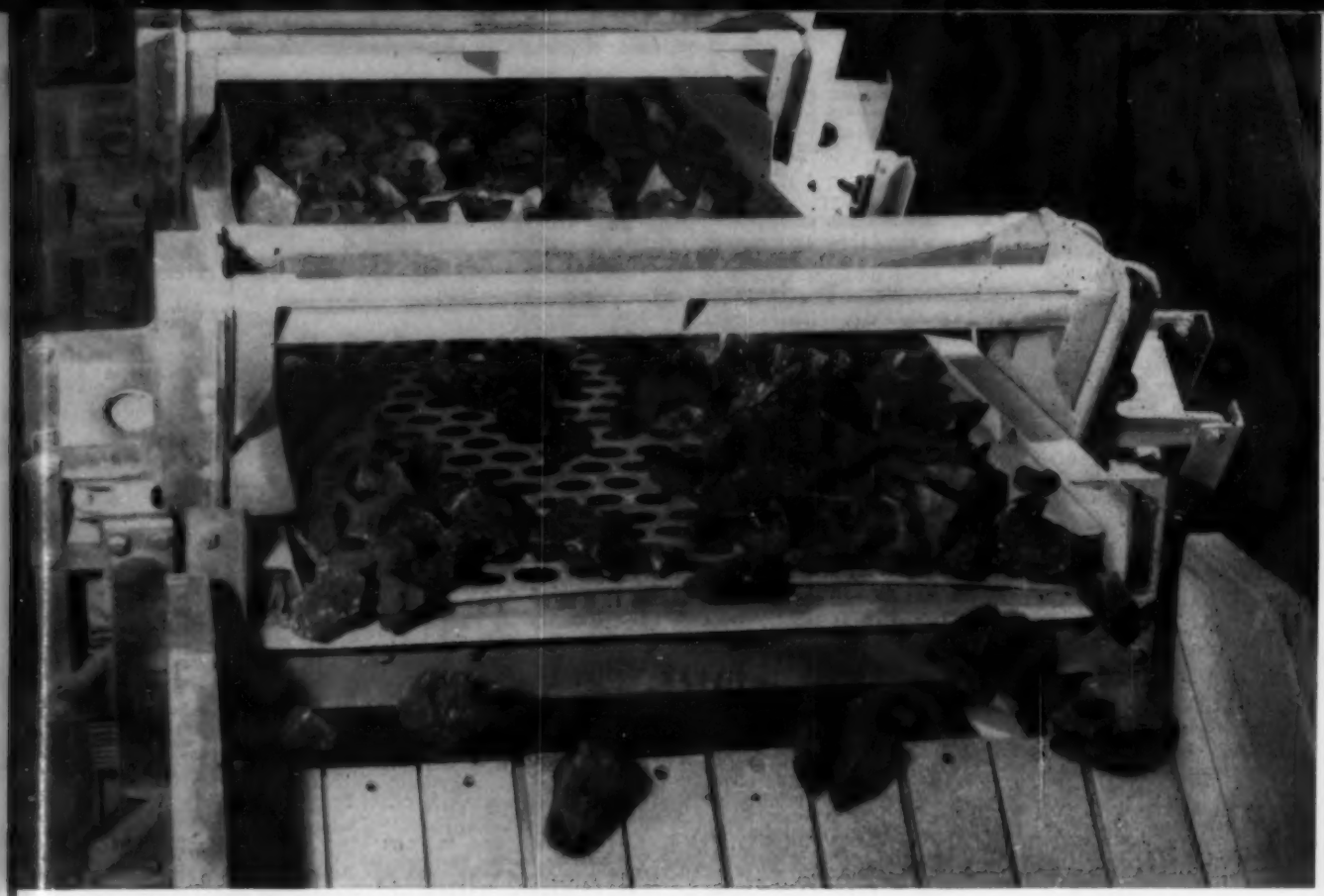
American Well Works
The Daniels Co., Contractors, Inc.
Denver Equipment Co.—"DENVER SUB-A"
Morse Bros. Machinery Co.—"JETAIR"
Ore Reclamation Co.
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.
The Stearns-Roger Mfg. Co.
Western Machinery Co.—"WEMCO FAGERGREN"
Wilmot Engineering Co.

FLOTATION PLANTS, PORTABLE

The Daniels Co., Contractors, Inc.
Denver Equipment Co.—"DENVER SUB-A"

FLOTATION REAGENTS

American Cyanamid Co. Explosives and Mining Chemicals Dept.—"AEROFROTH"®
American Minechem Co.—"MINEFROTH"
Denver Equipment Co.



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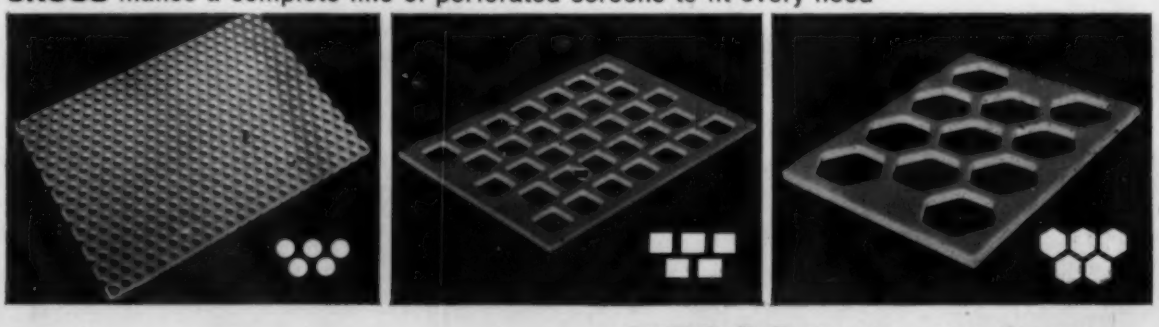

CROSS Perforated Metals

Carbondale, Pa.

NATIONAL STANDARD

The Dow Chemical Co.—"DOW-FROTH 250"
Hercules Powder Co.
Hodag Chemical Corp.

FLOTATION TESTING LABORATORIES

Commercial Testing & Engineering Co.
Denver Equipment Co.—"DENVER"
Galigher Co.

FLOW METERS

B-I-F Industries, Inc.

FLUID POWER COMPONENTS

The Commercial Shearing & Stamping Co.

FLUIDS, HYDRAULIC — See Hydraulic Fluids

FLUX, WELDING, SALVAGE EQUIPMENT

Robert Holmes & Bros., Inc.

FOOTMATS

Onox, Inc.

FORGINGS

American Chain Div., American Chain & Cable Co., Inc.

FORGINGS, DROP

Ladish Co.

FORGINGS, UPSET

New Departure Div., General Motors Corp.

FREEZEPROOFING CHEMICALS

American Minechem Co.
Fuel Process Co.—"FU PRO CO"
Morton Salt Co.—"FORMULA 5"
Wyandotte Chemicals Corp., Michigan Alkali Div.

FREEZEPROOFING OILS

Standard Oil Co. (Ind.)

FROTHERS

American Cyanamid Co., Explosives and Mining Chemicals Dept.—"AEROFROTH®"

FUEL OIL

Gulf Oil Corp.

FUELS

Pennsylvania Refining Co.

FURNACE ENCLOSURES

Bigelow-Liptak Corp.

FURNACE WALLS AND ARCHES

Geo. P. Reintjes Co.

FURNACES, ARCH AND WALL CONSTRUCTION

Bigelow-Liptak Corp.

FURNACES, HEAT DRYING

Bigelow-Liptak Corp.
Robert Holmes & Bros., Inc.
The Mine & Smelter Supply Co., Mfg. Div.—"SKINNER"
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.

FURNACES, HEAT TREATING

Hevi-Duty Electric Co.

FURNACES, HEATING

E. K. Campbell Co.—"THERMIDAIRE"
Dallas Engineers Inc., Coal-O-Matic Div.—"ANTHRAFLOW," "COAL-O-MATIC"

FURNACES, LABORATORY COMBUSTION

Central Scientific Co.
Fisher Scientific Co.
Hevi-Duty Electric Co.

FURNACES, METAL-MELTING

Kuhlman Electric Co.

FURNACES, NON-FERROUS METAL MELTING

Hevi-Duty Electric Co.

FURNACES, PLANT-HEATING, DIRECT-FIRED WARM-AIR

E. K. Campbell Co.—"THERMIDAIRE"

FURNACES, WARM-AIR, HEAVY-DUTY

E. K. Campbell Co.—"THERMIDAIRE"

FUSE BOXES, EXPLOSIONPROOF

Albert & J. M. Anderson Mfg. Co.

FUSE HOLDERS, BLASTING

Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.

FUSE HOLDERS, ELECTRICAL

Bussmann Mfg. Div., McGraw-Edison Co.—"BUSS"
Circuit Protective Devices Dept., General Electric Co.
Mosebach Electric & Supply Co.

FUSE REDUCERS, ELECTRICAL

Bussmann Mfg. Div., McGraw-Edison Co.—"BUSS"
Holub Industries, Inc.
Ideal Industries, Inc.
Trico Fuse Mfg. Co.

FUSE, DETONATING

Atlas Powder Co.
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc.
The Ensign-Bickford Co.—"PRIMACORD"
Hercules Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.

FUSE, SAFETY, BLASTING

Atlas Powder Co.
E. I. du Pont de Nemours & Co., Inc.
The Ensign-Bickford Co.
Hercules Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.

FUSES, ELECTRICAL

Bussmann Mfg. Div., McGraw-Edison Co.—"BUSS," "FUSETRON"
Economy Fuse & Mfg. Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Guyan Machy. Co.—"BUSSMAN"
Mining Machine Parts Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Standard Devices Co.
Trico Fuse Mfg. Co.—"TRICO"
Westinghouse Electric Corp.

GAGES, LIQUID-LEVEL

The Lunkenheimer Co.—"LUNKENHEIMER"

GAGES, PRESSURE, VACUUM

The Bristol Co.—"BRISTOLS"
Fischer & Porter Co.
Foxboro Co.
Hays Corp.
Helicoid Gage Div., American Chain & Cable Co., Inc.

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Minneapolis-Honeywell Regulator Co., Industrial Div.

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Gibraltar Equipment & Mfg. Co.—"GEMCO TRU-BLU"
The Leetonia Tool Co.
Nordberg Mfg. Co.

GALVANOMETERS, BLASTING

American Cyanamid Co., Explosives and Mining Chemicals Dept.
Hercules Powder Co.

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Mine Safety Appliances Co.—"W-8 METHANE, M-6 METHANE"
National Mine Service Co.

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E. D. Bullard Co.
The Fyr-Fyter Co.
Mine Safety Appliances Co.—"ALL-SERVICE"
Pulmosan Safety Equip. Co.

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The Garlock Packing Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Johns-Manville—"GOETZE "SPIROTALLIC"
Raybestos Manhattan, Inc., Manhattan Rubber Div.—"RM"
United States Rubber Co.

GASKETS, RUBBER

Hewitt-Robins Incorporated

GASOLINE HAMMERS

Syntron Co.

GEAR DRESSING

Swan-Finch Petrochemicals—"AEROSOL"

GEARMOTORS

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The Louis Allis Co.
J. D. Christian Engineers—"RITE-LO-SPEED"
Continental Gin Co., Ind. Div.
Electro Dynamic Div. of General Dynamics Corp.
Elliott Co.
Ensign Electric & Mfg. Co.
The Falk Corp.—"MOTOREDUCERS ALL-MOTOR"
Foote Brothers Gear & Machinery Corp.
General Electric Co., Apparatus Sales Div.
Hewitt-Robins Incorporated
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-59—"LINK-BELT," "GEARMOTORS," "MOTOGEARS"
The Master Electric Co., Div. Of Reliance Electric & Eng. Co.
Morse Bros. Machinery Co.
Mosebach Electric & Supply Co.
Ore Reclamation Co.
Reliance Elec. & Eng. Co.
W. J. Savage Co.
Sterling Electric Motors, Inc., —"STERLING SLO-SPEED"
Transall, Inc.
Westinghouse Electric Corp.

GEARMOTORS, RIGHT-ANGLE

Cone-Drive Gears Div., Michigan Tool Co.

GEARS

J. D. Christian Engineers
Coal Machinery Research, Inc.
Continental Gin Co., Ind. Div.
The Falk Corp.—"FALK"
Farrel-Birmingham Co., Inc.
Farrell-Cheek Steel Co.
Flood City Brass & Electric Co.
Foote Brothers Gear & Machinery Corp.—"DUTI-RATED"
FWD Corp.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-59
Marathon Coal Bit Co. Inc.—"MARATHON," "TRACY"
McNally-Pittsburg Mfg. Corp.
Mosebach Electric & Supply Co.
North American Machine Co. —"NAMCO"
Penn Machine Co.
Pittsburgh Gear Co.
W. J. Savage Co.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
Transall Inc.
Vulcan Iron Works
West Virginia Armature Co.
Westinghouse Electric Corp.
Wilmot Engineering Co.

GEARS, MINE-LOCOMOTIVE, HEAT-TREATED

Penn Machine Co.
Farrell-Cheek Steel Co.

GEARS, PLASTIC

Hewitt-Robins Incorporated
United States Rubber Co.

GEARS, REVERSE & REDUCTION

Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-59
Twin Disc Clutch Co.

GEARS, SEMI-STEEL

Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-59
McLanahan & Stone Corp.

GEARS, WORM

Cone-Drive Gears Div., Michigan Tool Co.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-59

GENERATOR CONTROL

Electric Machinery Mfg. Co.—"AUTO SYNCHRONIZEN"

GENERATORS, AC

Electric Machinery Mfg. Co.—"AMP-PAK"
Electric Products Co.

GENERATORS, AC, DC

American Mare Inc. (½ to 100-kw)
Westinghouse Electric Corp.

GENERATORS, DC

Electric Products Co.

GENERATORS, WATER WHEEL

Electric Machinery Mfg. Co.

GEOPHYSICAL SURVEYS, AIRBORNE

Fairchild Aerial Surveys, Inc.

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American Optical Co., Safety Products Div.
General Scientific Equipment Co.—"GS"
Johns-Manville—"WEARBESTOS"
Mine Safety Appliances Co.—"ALL-PURPOSE"
Pulmosan Safety Equip. Co.
Riegel Textile Corp.—"RIEGEL"

GLOVES, RUBBER

Continental Rubber Works
Fisher Scientific Co.
General Scientific Equipment Co. —"GS"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.

GLOVES, RUBBER, INDUSTRIAL

United States Rubber Co.

GOGGLE-CLEANING STATIONS

American Optical Co., Safety Products Div.
General Scientific Equipment Co. —"GS"
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
United States Safety Service Co. —"SAF-I-CUP"

GOGGLES

American Optical Co., Safety Products Div.
Bausch & Lomb Optical Co.
Chicago Eye Shield Co.
Fisher Scientific Co.
General Scientific Equipment Co. —"GS"
Marathon Coal Bit Co. Inc.—"WILSON"
Martindale Electric Co.
Mine Safety Appliances Co.—"SOFTSIDES"
Pulmosan Safety Equip. Co.
United States Safety Service Co. —"SAF-I-CUP"

GOVERNORS, COMPRESSED-AIR, UNLOADING

R. Conrader Co., Inc.—"CONRADER"

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Allis-Chalmers Mfg. Co.
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Colorado Fuel & Iron Corp.—"CF&I"
Electric Steel Foundry Co.
Galion Iron Works & Mfg. Co.
The Frank G. Hough Co.

GRADERS, MOTOR

Allis-Chalmers Mfg. Co.
Austin-Western, Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Caterpillar Tractor Co.
Galion Iron Works & Mfg. Co.
Huber-Warco Co.—"HUBER-WARCO"
LeTourneau-Westinghouse Co.

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The American Oil Co.
Joseph Dixon Crucible Co.
Esso Standard Oil Co.—"VAN CAZAR," "VAN ESTAN," "VAN NAKTA"
Keystone Lubricating Co.

GRATING, FLOOR, STAIR

Dravo Corp.
Hendrick Mfg. Co.
J. A. Zurn Mfg. Div., Zurn Industries, Inc.—"ZURN"

GRATING, STEEL

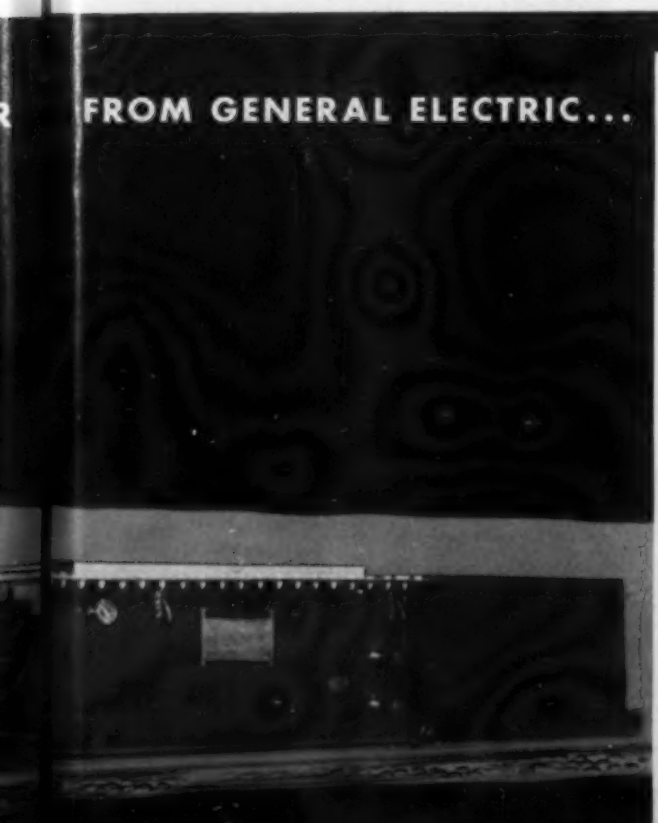
Blaw-Knox Co., Blaw-Knox Equipment Div.

GREASE-LINE EXTENSIONS AND FITTINGS

National Mine Service Co. (Clarkson Div.)—"CLARKS"

GREASES

The American Oil Co.
Bearings, Inc.



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"LO-BOY"

D-c power at 30% lower cost

General Electric's "Lo-Boy" portable silicon rectifier provides you with a new, more economical source of d-c power for mines, even thin seam mines. Here's why:

- **Low Initial Cost.** "Low-Boy" is priced about 30% less than mercury-arc rectifiers;
- **Requires Less Maintenance.** Except for cooling fans, there are no moving parts to wear out;
- **Easy Installation.** Sealed-dry transformer is one-half the weight of liquid-filled transformers. Rectifier car is 30% lighter than mercury-arc. Either car can be lifted by either end for easy handling.

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For more information, contact your G-E Apparatus Sales Engineer, or write to Section 532-1, General Electric Company, Schenectady 5, New York.

GENERAL ELECTRIC

Cities Service Oil Co.
Gulf Oil Co.
Hulburt Oil & Grease Co.
Lubriplate Div., Fiske Bros. Refining Co.—"LUBRIPLATE"
The Pure Oil Co.—"POCO HT-EP," "POCO GEARSHIELD," "POCO LOADER GREASE"
Sinclair Refining Co.—"LITH-OLINE," "SINCOLUBE," "PENNANT GREASES"
Socony Mobil Oil Co. Inc.

GREASES, HEAT & WATER RESISTANT

Hulburt Oil & Grease Co.
Socony Mobil Oil Co. Inc.
Swan-Finch Petrochemicals

GREASES, LITHIUM BASE

Socony Mobil Oil Co. Inc.
Sun Oil Co.—"PRESTIGE"

GREASE, MINE CAR

Hulburt Oil & Grease Co.
Pennsylvania Refining Co.
Sinclair Refining Co.—"No. 217"
Socony Mobil Oil Co. Inc.
Sun Oil Co.

GREASES, RUST-PREVENTIVE

Socony Mobil Oil Co. Inc.
Sun Oil Co.

GRINDERS, DRILL-BIT

Herold Mfg. Co.

GRINDERS, PEDESTAL, TOOL

South Bend Lathe Works

GRINDERS, PORTABLE

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Chicago Pneumatic Tool Co.
The Cincinnati Electrical Tool Co.
Guyan Machy. Co.—"BLACK & DECKER"
Ingersoll-Rand Co.
Joseph T. Ryerson & Son, Inc.
Thor Power Tool Co.

GRINDERS, STATIONARY

The Cincinnati Electrical Tool Co.
Fisher Scientific Co.
Lippmann Engineering Works Inc.
Remington Arms Co., Inc.
Joseph T. Ryerson & Son, Inc.
Snap-on Tools Corp.

GRINDING WHEELS

Guyan Machy. Co.—"CAR-BORUNDUM"
Kennametal, Inc., Mining Tool Div.
Marathon Coal Bit Co. Inc.—"SIMONDS"
Minnesota Mining & Mfg. Co.—"PG"
Norton Co.—"ALUNDUM CRYSTOLON"
Raybestos Manhattan, Inc. Manhattan Rubber Div.—"MANHATTAN"
Joseph T. Ryerson & Son, Inc.,
Snap-on Tools Corp.
United States Rubber Co.

GRINDING WHEELS, DIAMOND

Hoffman Brothers Drilling Co.
Norton Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
J. K. Smit & Sons—"SECOMET"

GRIZZLIES

Diamond Iron Works, Div. Goodman Mfg. Co.
Hammermills, Inc.
Hewitt-Robins Incorporated
Iowa Mfg. Co.
Kennedy Van Saun Mfg. & Eng. Co.
Link-Belt Co., Dept. CAMGL-59
Lippmann Engineering Works Inc.
McNally-Pittsburg Mfg. Corp.
Nordberg Mfg. Co.—"SYMONS"
Simplicity Engineering Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.—"LIVE ROLL"
Traylor Engineering & Mfg. Co.
W. S. Tyler Co.—"Ty-ROCK," "TYLER NIAGARA"

GRIZZLIES, VIBRATING

Syntron Co.

GROUND CLAMPS

Albert & J. M. Anderson Mfg. Co.
Duquesne Mine Supply Co.
Erico Products, Inc.—"CADDY"
Mossbach Electric & Supply Co.
Ohio Brass Co.
Trico Fuse Mfg. Co.—"KLIPLOK"

GROUND DETECTORS

Central Mine Supply Co. Div., Pickard Industries, Inc.—"PROTECTO"
National Mine Service Co.—"GROUND SENTINEL"

GROUND INDICATORS

Schroeder Brothers Corp.

GROUND RODS

Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"

GROUSER BARS

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Kensington Steel, Div. of Poor & Co.
Stula-Sickles Co.—"SSHI-C"

GROUTING

Cement Gun Co.—"GUNITE"
Hoffman Brothers Drilling Co.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Sika Chemical Corp.—"INTRAPLAST"

GROUTING EQUIPMENT

Sprague & Henwood

HACK-SAW BLADES

Disston Div., H. K. Porter Co., Inc.
Guyan Machy. Co.—"DISSTON"
Simonds Saw & Steel Co.—"RED END"
Snap-on Tools Corp.

HAMMERS, AIR

Acme Machinery Co.
Chicago Pneumatic Tool Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Joy Mfg. Co.
Mining Progress, Inc.
B. J. Nykerk Corp.—"HAUSHERR"
Penn Machine Co.
Schroeder Brothers Corp.
Thor Power Tool Co.
Worthington Corp.

HAMMERS, ELECTRIC

Homelite, a div. of Textron, Inc.—"HOMELITE-(BOSCH)"

HAMMERS, PORTABLE ELECTRIC

Black & Decker Mfg. Co.

HAMMERS, REPLACEABLE SOFT-FACE

Snap-on Tools Corp.

HANDLES, TOOL

The Leetonia Tool Co.
Marion Handle Mills, Inc.—"ACE, VIRGINIAN, A "GRADE"
The Salem Tool Co.—"BLACK DIAMOND," "PERFECT"

HANDRAIL & FITTINGS, ALUMINUM

Aluminum Co. of America

HANGERS, SHAFT—

See Shaft Hangers

HARDFACING FLUXES

The Lincoln Electric Co.—"LINCOLN WELD H535, H545 H550, H560."

HARDFACING MATERIALS

Air Reduction Sales Co., A Div. Air Reduction Co., Inc.
Alloy Rods Co.—"WEAR-ARC," "WEAR-FLAME," "WEAR-O-MATIC WIRE"
American Manganese Steel Div. American Brake Shoe Co.—"AMSCO"
Ampco Metal, Inc.—"AMPCO TRODE"
Coast Metals, Inc.
Crucible Steel Co. of America—"REXWELD"
Eutectic Welding Alloys Corp.—"EUTECHROMS" "TOOLTEC-TIC," "INSTANT HARDENER"
International Nickel Co., Inc.
The Lincoln Electric Co.—"ABRASOWELD," "MAN-GANWELD," "JET-HARD BU 90," "FACEWELD," "SURFACEWELD," "STAINWELD," "TOOL-WELD," "WEARWELD," "MANGJET"
Marathon Coal Bit Co. Inc.—"AIRCO"
Metal & Thermit Corp.—"HARDEX"
Resisto-Loy Co., Inc.—"RESISTO-LOY, ISOROD, "MANGA-TONE, NM," "CHROMO-LOY," "FLIN-TYPE V. H.," "TWO-TONE T. H.," "MANGA-KOTE" "HIGH SPEED N. M. HOT ROD"
The Sight Feed Generator Co.—"REXARC"
Stoody Co.—"STOODY"
Stula-Sickles Co.—"SEACO"
Taylor-Wharton Co. Div. Harsco Co.—"TIMANG"
Wall Colmonoy Corp.—"COL-MONOY"

HARDFACING SERVICE

American Alloy Corp.

HAULAGES, R. R. CAR BOAT

Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-59

HAULERS, FLAT-BED

LeTourneau-Westinghouse Co.

HAULING UNITS

Athey Products Corp.

HAULING UNITS, RUBBER TIRED

Athey Products Corp.

HAULS, CAR

Link-Belt Co., Dept. CAMGL-59

HEADLIGHTS

Ensign Electric & Mfg. Co.
Flood City Brass & Electric Co.
General Electric Co., Lamp Div.—"GENERAL ELECTRIC"
Guyan Machy. Co.—"GUYAN"
Imperial-Cantrell Mfg. Co.—"I. C."
Jeffrey Mfg. Co.

HEADLIGHTS, MINE LOCOMOTIVE

Schroeder Brothers Corp.

HEATER PANEL & UNITS

United States Rubber Co.—"USKON"

HEATERS, HOSE

United States Rubber Co.

HEATERS, OIL

Dravo Corp.
Hauck Mfg. Co.

HEATERS, UNIT

American Air Filter Co., Inc.
American-Standard Industrial Div.—"VENTURAFIN"
Buffalo Forge Co.—"BUFFALO"
E. K. Campbell Co.—"THER-MIDAIRE"
Clarage Fan Co.
Dravo Corp.
Ilg Electric Ventilating Co.—"ILG"
Westinghouse Electric Corp., Sturtevant Div.
L. J. Wing Mfg. Co. Div. of Aero Supply Mfg. Co. Inc.—"WING REVOLVING"

HEATING CABLE, LEAD-SHEATHED

Rockbestos Products Corp., Sub. of Cerro de Pasco Corp.

HEATING PLANTS

Axeman-Anderson Co.
Dravo Corp.

HEAVY-MEDIA RECLAMATION SYSTEMS

The Daniels Co. Contractors, Inc.—"DMS"
Nelson L. Davis Co.—"NELDCO"
Denver Equipment Co.—"DECO"
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-59
The Mine & Smelter Supply Co., Mfg. Div.—"AKINS"
Simplicity Engineering Co.
Western Machinery Co.—"WEMCO"

HEAVY-MEDIA SEPARATION PROCESS

The Daniels Co. Contractors, Inc.—"DMS"
Nelson L. Davis Co.—"NELDCO"
Dravo Corp.
Fairmont Machinery Co.
Fuel Process Co.
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-59
The Mine & Smelter Supply Co., Mfg. Div.—"AKINS"
K. Prins & Associates
Robert & Schaefer Co., Div. Thompson-Starrett Co., Inc.
Stearns Magnetic Products
Western Machinery Co.—"WEMCO MOBIL-MILL"

HEAVY-MEDIA SEPARATORS

Hardinge Co., Inc.
Link-Belt Co., Dept. CAMGL-59

HEEL BLOCKS, SWITCH

Bethlehem Steel Co.

HINGES, MINE-DOOR

National Mine Service Co. (Clarkson Div.)—"CLARK-SON"

HITCHINGS, MINE-CAR

American Car & Foundry Div., ACF Industries, Inc.
C. S. Card Iron Works
Duquesne Mine Supply Co.
Enterprise Wheel and Car Corp.
Irwin-Sensenich Corp.
National Malleable & Steel Castings Co.
Sanford Day Iron Works, Inc.

HOIST CONTROLLERS

Allis-Chalmers Mfg. Co.
Clark Controller Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Morse Bros. Machinery Co.
Vulcan Iron Works

HOIST HOOKS

Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY—LAUGHLIN"
Duquesne Mine Supply Co.
The Upson-Walton Co.

HOIST SIGNALLING COMMUNICATION

Femco, Inc.—"CAGE-PHONE"
Industrial Physics & Electronics Co.
Mine Safety Appliances Co.—"HOISTPHONE"

HOISTS, AIR

Gardner-Denver Company
Ingersoll-Rand Co.
Joy Mfg. Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"BUDGIT," "LOAD LIFTER"

HOISTS, CONSTRUCTION

American Hoist & Derrick Co.

HOISTS, ELECTRIC

American Engineering Co.—"LO-HED"
J. D. Christian Engineers
Coffing Hoist Div., Duff-Norton Co.—"QUIK-LIFT"
Guyan Machy. Co.—"SHAW-BOX"
Harnischfeger Corp.
Robert Holmes & Bros., Inc.
Hewitt-Robins Incorporated
Ingersoll-Rand Co.
Joy Mfg. Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"BUDGIT," "LOAD LIFTER"
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
Robbins & Myers, Inc.—"R & M"
Joseph T. Ryerson & Son, Inc.
Sanford Day Iron Works, Inc.
Sauerman Bros., Inc.
Shepard Niles Crane & Hoist Corp.
The Stearns-Roger Mfg. Co.
Stephens-Adamson Mfg. Co.
Vulcan Iron Works
Yale & Towne Mfg. Co.—"MIDGET KING," "CABLE KING," "LOAD KING"

HOISTS, ELECTRIC AND GASOLINE

Clyde Iron Works, Inc.

HOISTS, GASOLINE

Joy Mfg. Co.

HOISTS, HAND

J. D. Christian Engineers
Coffing Hoist Div., Duff-Norton Co.—"SAFETY PULL, "SU-PER POWER"
Denver Equipment Co.—"DENVER"
Harnischfeger Corp.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"BUDGIT," "TUGIT," "SHAW BOX"
Morse Bros. Machinery Co.
Ore Reclamation Co.
Robbins & Myers, Inc.—"R & M"
Joseph T. Ryerson & Son, Inc.
Stephens-Adamson Mfg. Co.

POWERING EQUIPMENT AT PEABODY'S *River King Mine*

. . . FURNISHING POWER FOR AUXILIARY SHOVEL EQUIPMENT

SPECIFICATIONS:

1—Portable Switchgear for shovel feeder cables, which incorporate ground fault protection and, if required, ground continuity.

2—Portable Transformers from 75 to 300 KVA, with secondary ground current limiting and protection equipment. A complete unit from high voltage power connectors to low voltage receptacles.

3—Portable power cable connection skids.

4—Portable power cable disconnect sectionalizing equipment.

All apparatus used in the cable distribution of open pit strip mining is engineered to suit the exacting requirements of the individual mine and of its operating personnel.

Discussion of your problems will be welcomed by our engineering staff and proposed outline drawings of our recommendations will be furnished promptly.

• ***Your inquiries are requested by mail or telephone.***

ATKINSON ARMATURE WORKS

PITTSBURG . . . . KANSAS

Yale & Towne Mfg. Co.—"PULLIFT," "LOAD KING"

HOISTS, LAYER-LOADING

Robert Holmes & Bros, Inc.
Sanford Day Iron Works, Inc.

HOISTS, LOADING-BOOM

Morse Bros. Machinery Co.
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.
Sanford Day Iron Works, Inc.
Shepard Niles Crane & Hoist Corp.

HOISTS, MONORAIL

American Engineering Co.—"LO-HED"
Coffing Hoist Div., Duff-Norton Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"BUDGIT," "TUGIT," "SHAW BOX"
Robbins & Myers, Inc.—"R & M"
Joseph T. Ryerson & Son Inc.
Shepard Niles Crane & Hoist Corp.

HOISTS, PORTABLE

Chicago Pneumatic Tool Co.
Coffing Hoist Div., Duff-Norton Co.
Denver Equipment Co.—"DENVER"
Flood City Brass & Electric Co.
Guyan Machy. Co.—"BUDGIT"
Harnischfeger Corp.
Ingersoll-Rand Co.
Joy Mfg. Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"BUDGIT," "TUG-IT," "SHAW BOX"
Robbins & Myers, Inc.—"R & M"
Ruger Equipment, Inc.
Joseph T. Ryerson & Son, Inc.
Schroeder Brothers Corp.
Shepard Niles Crane & Hoist Corp.
Yale & Towne Mfg. Co.—"LOAD KING"

HOISTS, SCRAPER

American Hoist & Derrick Co.—"AMERICAN"
Ingersoll-Rand Co.
Joy Mfg. Co.
Sauerman Bros., Inc.

HOISTS, SHAFT

Connellsville Mfg. & Mine Supply Co.
Robert Holmes & Bros., Inc.
Joy Mfg. Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"SHAW-BOX"
Mayo Tunnel & Mine Equipment—"KOEPE"
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
Vulcan Iron Works

HOISTS, SHAFT, FRICTION-TYPE

Connellsville Mfg. & Mine Supply Co.

HOISTS, SKIP

Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-59

HOISTS, SLOPE

Robert Holmes & Bros., Inc.
Joy Mfg. Co.
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
Vulcan Iron Works

HOISTS, TRUCK-BODY

Galion Allsteel Body Co.
Gar Wood Industries, Inc.
Hercules Steel Products Co.
Hockensmith Corp.—"PENN"
Marion Metal Products Co.
Perfection Steel Body Co.
Vickers, Inc., Tulsa Winch Div.

HOLDBACKS, CONVEYOR

Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-59
Stephens-Adamson Mfg. Co.

HOPPERS—See Bins & Hoppers, Coal, Storage & Blending

HOPPERS, WEIGH

Industrial Physics & Electronics Co.
The Nolan Co.
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.

HOSE, AIR

Acme-Hamilton Mfg. Corp.
Acme Machinery Co.
Aeroquip Corp.
Anchor Coupling Co., Inc.
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Carlyle Rubber Co., Inc.
Chicago Pneumatic Tool Co.
Continental Rubber Works—"VITAULIC," "LIBERTY," "TRIBUNE," "ENDURO"
Elmco Corp.
The Gates Rubber Co. Sales Div., Inc.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"COMMANDER," "TYPE 88," "TYPE 50," "MAXEGON ALL PURPOSE"
Goodyear Tire & Rubber Co.
Guyan Machinery Co.
Hewitt-Robins Incorporated—"MONARCH," "AJAX," "HEWITT," "MALTESE CROSS"
Joy Mfg. Co.
Lincoln Engrg. Co. Div. of McNeil Mach. & Engrg. Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.
Ore Reclamation Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"TOWER"
Schroeder Brothers Corp.
Thermoid Co.
Thermoid Div., H. K. Porter Co., Inc.
Thor Power Tool Co.
United States Rubber Co.
Weatherhead Co., Fort Wayne Div.

HOSE, AIR-SHOOTING

Airdox Cardox Products Co.
Aeroquip Corp.
Central Mine Supply Div., Pickard Industries, Inc.—"SEAL-TITE"

HOSE, CLAMPS

Hose Accessories Co.

HOSE, COAL WASHING

B. F. Goodrich Industrial Products Co.—"CONVERTAPIPE"

HOSE, CONDUIT

Guyan Machy. Co.

HOSE, FIRE

Acme-Hamilton Mfg. Corp.
American LaFrance, Div. of Sterling Precision Corp.— "AMERICAN LA FRANCE," "GOODYEAR"
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Carlyle Rubber Co., Inc.
The Fyr-Fyter Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"PINNACLE" "COMMANDER," "SOLAR," "MAINSTAY," "CASCADE," "B.F.G.," "SIGNAL"
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated—"AJAX," "MONARCH," MALTESE CROSS"

STAMLER HAS NEVER BUILT A FAILURE!

* EVERY SINGLE STAMLER CAR SPOTTER EVER BUILT is still in service . . . still loading coal at the LOWEST POSSIBLE cost per ton . . . and still operating at a parts-and-maintenance cost SO LOW that it is practically impossible to figure per 100,000 tons!

* THAT'S WHY Stamler right now is enjoying a greater percentage of repeat business than ever before!

STAMLER Hydraulic CAR SPOTTERS

When are YOU going to realize that it is COSTING you money NOT to use Stamler Car Spotters?

SCHROEDER BROTHERS, Exclusive Eastern Sales Agent
Pittsburgh, Pennsylvania
UNION INDUSTRIAL CORP., Carlsbad, New Mexico

W. R. STAMLER CORPORATION
PARIS, KENTUCKY

SALMON & CO., Birmingham, Alabama
WESTERN SALES ENGINEERING CO.,
Salt Lake City, Utah

Mine Safety Appliances Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"REPUBLIC"
Thermoid Div., H. K. Porter Co., Inc.
United States Rubber Co.

HOSE, FLEXIBLE

Aeroquip Corp.
Anchor Coupling Co., Inc.
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Compton, Inc.
Farris Flexible Valve Corp.—"FLEX VALVE," "SUPER SEAL"
Flexaust Co.—"FLEXAUST"
Franklin Plastics, Inc.—"DUR X PLASTIC," "CROWN" "SUPREME"
Goodall Rubber Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Thermoid Div., H. K. Porter Co., Inc.
Thermoid Co.
United States Rubber Co.
Weatherhead Co., Fort Wayne Div.

HOSE, FLEXIBLE METAL

Cobra Metal Hose, Div. DK Mfg. Co.

HOSE, FLEXIBLE, MINE

Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Carlyle Rubber Co., Inc.
Elmco Corp.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"CONVERTA-PIPE"
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Raybestos Manhattan Inc., Manhatan Rubber Div.
Thermoid Co.

HOSE, GAS

Hewitt-Robins Incorporated
Raybestos Manhattan, Inc., Manhattan Rubber Div.
United States Rubber Co.

HOSE, GASOLINE

B. F. Goodrich Industrial Products Co.—"TYPES 72, 72-A, 72-W PUMP HOSE," TYPE 79 & 82-A TANK HOSE" "TYES 83 & 83-A FUEL OIL HOSE"
Hewitt-Robins Incorporated

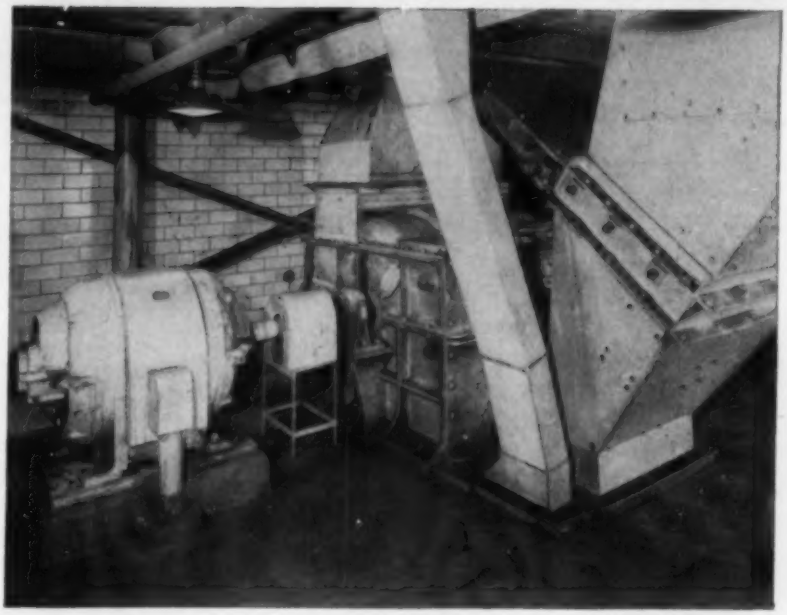
HOSE, GREASE & OIL

Aeroquip Corp.
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Lincoln Engrg. Co. Div. of McNeil Mach. & Engrg. Co.
Raybestos Manhattan Inc., Manhatan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.
Stewart-Warner Corp., Alemite Div.
Thermoid Co.
Weatherhead Co., Fort Wayne Div.

HOSE, HYDRAULIC

Aeroquip Corp.
Anchor Coupling Co., Inc.
Blackhawk Mfg. Co.
Carlyle Rubber Co., Inc.
Central Mine Supply Co., Div., Pickard Industries, Inc.—"SEALTITE"
Champ Industries, Inc.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
Flood City Brass & Electric Co.
The Gates Rubber Co. Sales Div., Inc.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Guyan Machy. Co.—"EASTMAN"
Hewitt-Robins Incorporated
Mining Machine Parts, Inc.
National Mine Service Co.

CRUSHING FACTS



American "Rolling Ring" Coal Crusher
splits coal . . . smashes maintenance costs!

In almost five years, the above American Coal Crusher has reduced 1,800,000 tons of 2" x 0" coal to a ¾" x 0" product for a prominent midwestern utility. Since installation, this unit has handled an average annual tonnage of 450,000, with a very low ratio of replacement parts to tonnage. The operating engineer for this utility says, "We have experienced no stoppages . . . crusher operation and maintenance have been very satisfactory."

"Rolling Ring" design makes the difference. Specially designed rotor, consisting of four rows of patented shredder rings, each suspended on a single shaft, rotate freely at a relatively *slow speed.* Coal is *split* rather than smashed. This splitting action saves both power and maintenance, gives more uniform sizing, fewer fines. Rings can be reversed to give extended life.

American has manufactured reduction equipment since 1908 and you can be sure that "When you figure costs, the best results come from American *Rolling Ring* Crushers." If you have a coal preparation problem, why not write today for recommendations and literature. Our highly-trained engineering staff will give you prompt assistance.

American PULVERIZER COMPANY
ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS
1119 MACKLIND AVE. ST. LOUIS 10, MO.

Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"WIRETEX"
Schroeder Brothers Corp.
Stewart Warner Corp., Alemite Div.
Thermoid Co.
United States Rubber Co.
Weatherhead Co., Fort Wayne Div.

HOSE, ROCK-DUST

American Mine Door Co.
B. F. Goodrich Industrial Products Co.—"DUSTEX."
Hewitt-Robins Incorporated
Mine Safety Appliances Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.

HOSE, STEAM

Acme-Hamilton Mfg. Corp.
Aeroquip Corp.
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Hewitt-Robins Incorprated
Raybestos Manhattan Inc., Manhattan Rubber Div.
United States Rubber Co.

HOSE, SUCTION, DISCHARGE

Acme-Hamilton Mfg. Corp.
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Carlyle Rubber Co., Inc.
Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
The Gates Rubber Co. Sales Div., Inc.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"CASCADE," "MAXECON," "MORECON," "SPIROLOCK," "TYPE 81 FOR WATER," "TYPES 400, 200, 150, 100, FOR OIL," "TYPE 82-A FOR GASOLINE"
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Raybestos Manhattan Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.
Thermoid Co.
Thermoid Div., H. K. Porter Co., Inc.
United States Rubber Co.

HOSE, WATER

Acme-Hamilton Mfg. Corp.
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Carlyle Rubber Co., Inc.
Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
Flood City Brass & Electric Co.
Franklin Plastics, Inc.—"DUR X PLASTIC," "SUPREME"
The Gates Rubber Co. Sales Div., Inc.
Gering Products, Inc.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"JUPITER DELUGE ALARM"
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated—"MONARCH," "AJAX," "HEWITT"
Lincoln Engrg. Co., Div. of McNeil Mach & Engrg. Co.
Ore Reclamation co.
Plymouth Rubber Co. Inc.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"TONKA"
Thermoid Co.
Thermoid Div., H. K. Porter Co., Inc.
United States Rubber Co.

HOSE ASSEMBLIES, SPLIT FLANGE

Anchor Coupling Co. Inc.

HOSE FITTINGS

Aeroquip Corp.—"SOCKETLESS," "LITTLE GEM," "SUPER GEM"
Airdox Cardox Products Co.
Anchor Coupling Co., Inc.
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Carlyle Rubber Co., Inc.
Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co.
Continental Rubber Works
Flood City Brass & Electric Co.
The Gates Rubber Co. Sales Div., Inc.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Hose Accessories Co.
Lincoln Engrg. Co., Div. of McNeil Mach. & Engrg. Co.
Mining Machine Parts, Inc.
Parker Fittings & Hose Div., Parker Hannifin Corp.—"HOZE-LOK"
Schroeder Brothers Corp.
Standard Devices Co.
Weatherhead Co., Fort Wayne Div.

HOSE FITTINGS, DETACHABLE & REUSABLE

Aeroquip Corp.
Anchor Coupling Co., Inc.
Carlyle Rubber Co., Inc.
Continental Rubber Works
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Hose Accessories Co.
Hunt Valve Co.—"QUIK-AS-WINK"
Lincoln Engrg. Co., Div. of McNeil Mach. & Engrg. Co.—"LOKTITE"
Mining Machine Parts, Inc.
Schroeder Brothers Corp.
Standard Devices Co.
Thermoid Co.
Weatherhead Co., Fort Wayne Div.

HOSE FITTINGS, HYDRAULIC

Aeroquip Corp.
Anchor Coupling Co., Inc.
Carlyle Rubber Co., Inc.
Champ Industries, Inc.
Compton, Inc.
Continental Rubber Works
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Hose Accessories Co.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
Schroeder Brothers Corp.
Standard Devices Co.
Stewart-Warner Corp., Alemite Div.
Thermoid Co.
United States Rubber Co.
Weatherhead Co., Fort Wayne Div.

HOSE FITTINGS, SWAGED

Weatherhead Co., Fort Wayne Div.

HOSE & TUBE COMBINATIONS

Anchor Coupling Co. Inc.

HYDRAULIC ACCUMULATORS

Parker Hydraulics Div., Parker-Hannifin Corp.—"PARKER"
Schroeder Brothers Corp.

HYDRAULIC CONTROL UNITS

Caterpillar Tractor Co.

HYDRAULIC CYLINDERS

Blackhawk Mfg. Co.
Hydreco Div., The New York Air Brake Co.—"HYDRECO"
Joy Mfg. Co.
Ledeen, Inc.
Schroeder Brothers Corp.
Star Jack Co., Inc.
Vickers Incorporated

HYDRULIC CYLINDERS, PUMPS, VALVES, REBUILT

Leman Machine Co.

HYDRAULIC FLUID

The American Oil Co.
Cities Service Oil Co.
D-A Lubricant Co., Inc.—"D-A"
Esso Standard Oil Co.—"TERESSO," "ESSTIC," "NUTO," "NURAY," "CORAY," "UNIVIS"
Hulbert Oil & Grease Co.
Keystone Lubricating Co.
Shell Oil Co.
Sinclair Refining Co.—"DURO"
Socony Mobil Oil Co. Inc.
Sun Oil Co.—"SOLNUS," "SUNTAC," "SUNVIS" MINE-TAC," "SUNVIS" MINE-SAFE"
Texaco, Inc.

HYDRAULIC FLUIDS, FIRE-RESISTANT

Monsanto Chemical Co.
Shell Oil Co.—SHELL 3XF MINE FLUID"
Socony Mobil Oil Co. Inc.
Swan-Finch Petrochemicals

HYDRAULIC POWER UNITS

Schroeder Brothers Corp.

HYDRAULIC PUMPS

American Engineering Co.—HELE-SHAW," HYRAMITE"
Blackhawk Mfg. Co.
Compton, Inc.
Denison Engineering Div., American Brake Shoe Co.
Gar Wood Industries, Inc.
General Equipment & Manufacturing Co.
Hydreco Div., The New York Air Brake Co.—"HYDRECO"
Joy Mfg. Co.
Schroeder Brothers Corp.
Star Jack Co., Inc.
Vickers Incorporated
Worthington Corp.

HYDRAULIC PUMPS, REBUILDING, REPAIR

Meckum Engineering, Inc.
West Virginia Armature Co.

HYDRAULIC PUMPS, REBUILT

National Mine Service Co.

HYDRAULIC SYSTEMS CENTRAL

Aldrich Pump Co.

HYDRAULIC VALVES

Blackhawk Mfg. Co.
A. W. Cash Co.
Denison Engineering Div., American Brake Shoe Co
Hunt Valve Co.—"QUIK-AS-WINK"
Hydreco Div., New York Air Brake Co.—"HYDRECO"
Ledeen, Inc.
The Lunkenheimer Co.—"LUNKENHEIMER"
Parker Hydraulic Div., Parker-Hannifin Corp.—"PARKER"
Schroeder Brothers Corp.
Star Jack Co., Inc.
Vickers Incorporated
Walworth Co.

HYDROSEPARATORS

Bird Machine Co.
Denver Equipment Co.—"DENVER," "HYDRO-CLASSIFIER"
Dorr-Oliver, Incorporated
Hardinge Co., Inc.
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.
Western Machinery Co.—"WEMCO"

INDICATING LIGHTS

Cutler-Hammer, Inc.—"PRESTEST"

INDICATING LIGHTS, OILTIGHT

Cutler-Hammer, Inc.

INDICATORS, DATA-DISPLAY AND TRANSFER

Union Switch & Signal Div. of Westinghouse Air Brake Co.

INDICATORS, REMOTE

Allis-Chalmers Mfg. Co.
B-I-F Industries, Inc.
The Bristol Co.—"BRISTOL'S"
Fischer & Porter Co.
General Electric Co., Apparatus Sales Div.
Hays Corp.
Hewitt-Robins Incorporated
Industrial Physics & Electronics Co.

INDICATORS, SIGHT-FEED AND WATER

The Lunkenheimer Co.—"LUNKENHEIMER"

INDICATORS, SPEED, ELECTRIC

Reliance Electric and Eng. Co.

INDICATORS, TEMPERATURE

West Instrument Corp—"VERI-TELL"

INDUSTRIAL EQUIPMENT

Delta-Star Electric Div., H. K. Porter Co., Inc.

INSTRUMENTS, BLASTING-VIBRATION

W. F. Sprengnether Instrument Co., Inc.

INSTRUMENTS, FLOW-INDICATING

New Jersey Meter Co., Inc.—"FLO-SIG," "TOOL-OM-ETER "DRILL-OM-ETER"

INSTRUMENTS—HYDRAULIC CIRCUIT TESTING

Schroeder Brothers Corp.

INSTRUMENTS, RECORDING PRESSURE, TEMPERATURE, ETC.

B-I-F Industries, Inc.—"FLO-WATCH," "CHRONOFLO"
The Bristol Co.—"BRISTOL'S"
Fischer & Porter Co.
Fisher Scientific Co.
Foxboro Co.
Hays Corp.
Industrial Physics & Electronics Co.
Minneapolis-Honeywell Regulator Co., Industrial Div.
West Instrument Corp.—"MARKSMAN"

INSTRUMENTS, ROOF-CONTROL

Herold Mfg. Co.

INSULATING MATERIALS, ELECTRICAL

Dow Corning Corp.
Duquesne Mine Supply Co.
General Electric Co., Chemical and Metallurgical Div., Insulating Materials Dept.
Irvington Div. of Minnesota Mining & Mfg. Co.
Johns-Manville—"FIBROID," "ARMATURO," "QUINTERRA," "QUINTERRABORD" "QUINORGO," "QUINORGOBORD"
Keasbey & Mattison Co.
Minnesota Mining & Mfg. Co.—"SCOTCHFIL," "SCOTCH CAST BRAND RESIN"
National Electric Coil Div. of McGraw-Edison Co.
Pennsylvania Electric Coil Corp.
Shell Oil Co.
United States Rubber Co.
West Virginia Armature Co.

INSULATING MATERIALS, HEAT & COLD

Bigelow-Liptak Corp.
Philip Carey Mfg. Co.—"CAREYCEL" "CAREY-TEMP," "AIRCELL," "IMPERVO-PERFECTO-EXCEL"
Johns-Manville—"SUPER-EX," "ASBESTO-SPONGE," "THERMOBESTOS," "ROCK CORK," "ZEROLITE," "FIBROCEL," "THERMO-FLEX," "ASBESTOCEL," "SPINTEX," "BANROC" "MICROLITE"
Keasbey & Mattison Co.
Mexico Refractories Co.—"PLASTIC," "VEE-BLOCK CASTABLE," "M-5," "I-R-C"
Pittsburgh Corning Corp.—"FOAMGLAS"
Pittsburgh Plate Glass Co.—"PPG FIBER GLASS" "SELETROFOAM"
The Ruberoid Co.
United States Rubber Co.

INSULATING MATERIALS, NOISE

Johns-Manville—"SPIN COUSTIC," "SANACOUSTIC," "PERMACOUSTIC," "FIBRETONE," "AIRACOUSTIC"
Keasbey & Mattison Co.—"SPRAYED LIMPET," "ASBESTOS"
Minnesota Mining & Mfg. Co.—"SCOTCH BRAND"
Pittsburgh Plate Glass Co.—"PPG FIBRE GLASS" "SELETROFOAM"
United States Rubber Co.

INSULATING MATERIALS, THERMAL

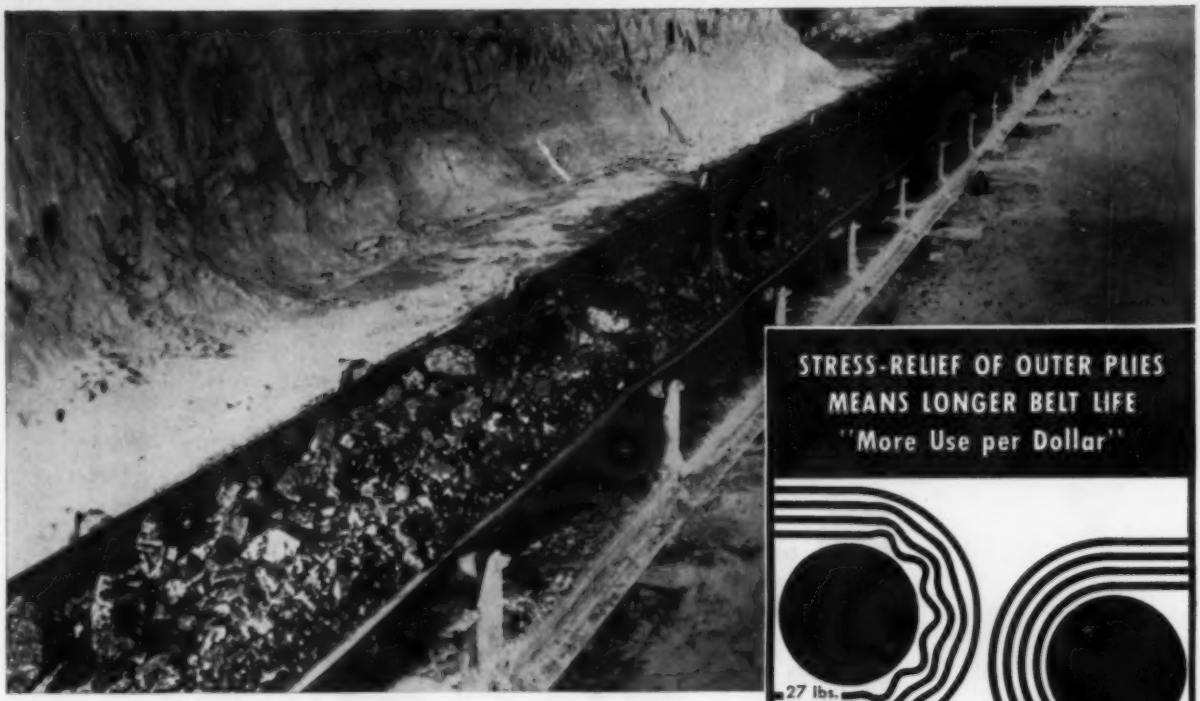
Dow Corning Corp.

INSULATORS

Albert & J. M. Anderson Mfg. Co.

INSULATORS, ELECTRIC

Delta-Star Electric Div., H. K. Porter Co., Inc.
The Elreco Corp.



RIP RESISTANT
RAY-MAN CONVEYOR BELT
HAULS *MORE* COAL... LASTS *LONGER!*

Ray-Man Conveyor Belt trains *naturally*, troughs *easily*... handles *more* coal even where small pulleys are required in low head-room operations. Special cushioned strength members, and Double-Compensation to relieve outer-ply stress, provide needed impact resistance *plus* exceptional flexibility. Ray-Man is highly rip resistant... requires *no* breaker-strip and holds fasteners better than any other belt construction. Exclusive "XDC" Cover adds additional protection against wear, tear, cuts and abrasion never before possible!

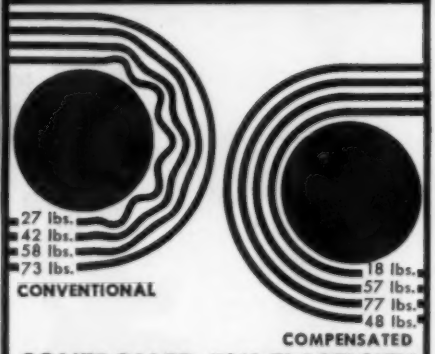
Like all Manhattan underground belts, Ray-Man is mildew-proof, moisture resistant—and available with Bureau of Mines' acceptance designation: "Fire-Resistant, U.S.B.M. No. 28-10." Ray-Man does a *better* job, *longer*... and it's *safer* to use!

Let an R/M representative show you special advantages of other R/M conveyor belts... Homocord for unusually severe shock loading, R/M Tension-Master for extra long lifts, high tensions. There's an R/M heavy duty belt to give "More Use per Dollar" on every handling job.

R/M POLY-V® DRIVE—Patented new concept "trouble-proofs" your mine drives. Delivers up to 50% more power in same space as ordinary V-belt drives... or equal power in less space! Single V-ribbed belt eliminates "matching" problems... minimizes belt and sheave inventories. Write for Poly-V® Drive Bulletin M141 today.

®Poly-V is a registered Raybestos-Manhattan trademark.

STRESS-RELIEF OF OUTER PLIES MEANS LONGER BELT LIFE
"More Use per Dollar"



CONTROLLED PLY ELASTICITY

Note how Double-Compensation at right equalizes ply stresses.

1. Center plies on neutral axis and better protected carry more load.
2. Outer plies stress-relieved by adjusting to tension and compression.

INDUSTRY'S *ONLY* COMPENSATED BELT

Ray-Man Compensation relieves outer ply stress... allows outside ply to elongate more than inner plies as the belt flexes around the pulleys. Inner plies no longer "loaf", but carry full share of the load.

Outer ply is better able to absorb strain and impact of loading, pull as a strength member, *protect* the inner plies, hold fasteners or splice longer.

And, because Ray-Man is *double Compensated*—both top and bottom plies stress-relieved—Ray-Man Compensation prolongs belt life, even where operated over reverse bend, snub or take-up pulleys!

RM613

BELTS • HOSE • ROLL COVERINGS • TANK LININGS • INDUSTRIAL RUBBER SPECIALTIES

MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Other R/M products: Abrasive and Diamond Wheels • Brake Blocks and Linings • Clutch Facings • Asbestos Textiles • Mechanical Packings • Engineered Plastics • Sintered Metal Products • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

SIMPLEX MINE JACKS

6 WAYS BETTER

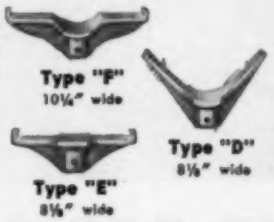
★ Ratchet lowering lever type for speed with safety
★ 5-tons capacity (other models to 35 tons)
★ Double-lever sockets permit lifting in close quarters
★ Full capacity on cap *OR GROOVED* toe
★ Safety Speed Trigger
★ Ideal for re-railing, repairs, skidding

Hi-Speed TIMBER JACK

MODEL NO. 642
LIFTS 6 TONS

Combines safety of screw jack with fast action of crank. Head swivels. Five models with min. ht. from 3'6", max. ht. to 9'6".

3 TYPES OF HEADS



Write for Mines Bulletin for data on the most complete line of Mine Jacks

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WORLD'S LARGEST MFGRS. OF INDUSTRIAL MECHANICAL AND HYDRAULIC JACKS
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Star Jack Co., Inc.
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McNally-Pittsburg Mfg. Corp.
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(for other Sun News, read the ad on page 47 of this issue)

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Joseph Dixon Crucible Co.
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Insley Manufacturing Corp.
International Harvester Co., Construction Equipment Div. —"SKID-SHOVEL"
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Myers-Whaley Co.—"WHALEY AUTOMAX"
Sanford Day Iron Works, Inc.
Tractomotive Corp.—"TRACTOSHOVEL"

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Clark Equipment Co., Construction Machinery Div.—"MICHIGAN"
The Frank G. Hough Co.—"PAYLOADER"
Insley Manufacturing Corp.
Koehring Div. of Koehring Co.
Link Belt Speeder Corp.
Tractomotive Corp.—"TRACTOLOADER"

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International Harvester Co., Construction Equipment Div.
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Kanawha Mfg. Co.
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Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.
W. J. Savage Co.
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Joy Mfg. Co.
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Morse Bros. Machinery Co.
Myers-Whaley Co.—"WHALEY AUTOMAX"

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National Mine Service Co.— "CLARKSON"

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Elastic Stop Nut Corp. of America—"ELASTIC STOP NUTS"
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National Electric Products Co.
The Palnut Co.—"PALNUT"
Republic Steel Corp.—"REPUBLIC NYLOK"

LOCOMOTIVES, AIR

Eimco Corp.

LOCOMOTIVES, BATTERY

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Differential Steel Car Co.
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General Electric Co., Apparatus Sales Div.
General Electric Co., Locomotive & Car Equipment Dept.
Plymouth Locomotive Works, Div. of The Fate-Root-Heath Co.—"PLYMOUTH"
Vulcan Iron Works

LOCOMOTIVES, DIESEL HYDRAULIC

General Electric Co., Locomotive & Car Equipment Dept.

LOCOMOTIVES, DIESEL, SURFACE

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Diesel Energy Corp.
Fairbanks Morse & Co.
Plymouth Locomotive Works, Div. of The Fate-Root-Heath Co.—"PLYMOUTH TORQOMOTIVE"
Vulcan Iron Works

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Mancha Storage Battery Locomotive Div., Goodman Mfg. Co.
National Mine Service Co.
Plymouth Locomotive Works, Div. of The Fate-Root-Heath Co.—"PLYMOUTH MINE-O-MOTIVE"

LOCOMOTIVES, GASOLINE, SURFACE

Plymouth Locomotive Works, Div. of The Fate-Root-Heath Co.—"PLYMOUTH TORQOMOTIVE"

LOCOMOTIVES, REBUILT

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Jeffrey Mfg. Co.
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National Mine Service Co.
West Virginia Armature Co.

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D-A Lubricant Co., Inc.—"D-A"
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Hulburt Oil & Grease Co.
Keystone Lubricating Co.
New York & New Jersey Lubricant Co.—"NON-FLUID OILS"
Ohio Oil Co.
Pennsylvania Refining Co.
The Pure Oil Co.—"POCO PB GEAR LUBRICANTS"
Shell Oil Co.
Sinclair Refining Co.—"JET" "ONYX" "OPALINE MP"
Socony Mobil Oil Co. Inc.
Standard Oil Co. (Ind.)
Stewart-Warner Corp., Alemite Div.
Sun Oil Co.—"SOLNUS," "SUNTAC," "SUNVIS," "SUN 740A-EP LUBRICANT"
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Texaco, Inc.
Tidewater Oil Co.
Valvoline Oil Co., Div. of Ashland Oil & Refining Co.—"VALVOLENE"
Warren Refining & Chemical Co. "PLASTILUBE," "BUSTRUX," "PLASTIGEAR," "GREEN GOLD," "WARCO," "STAYS IN," "LITHOLUBE"
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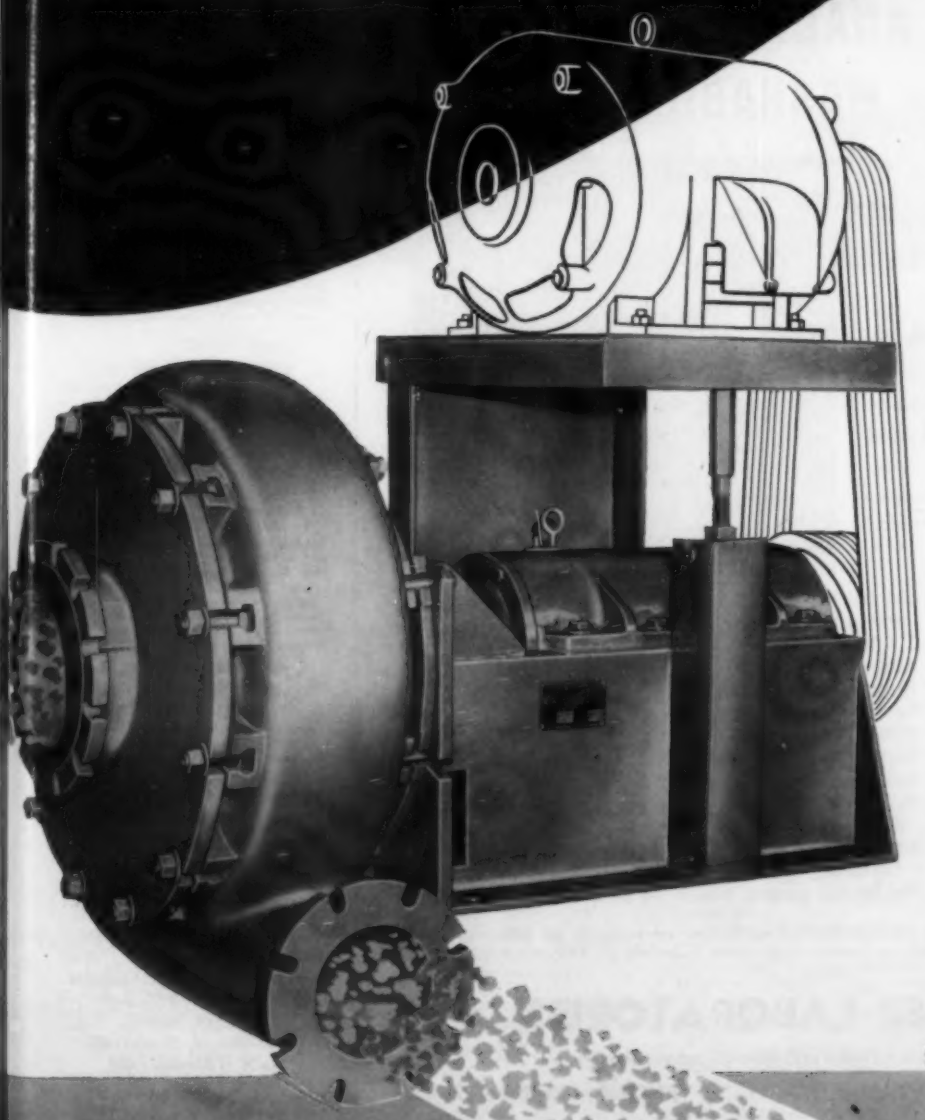

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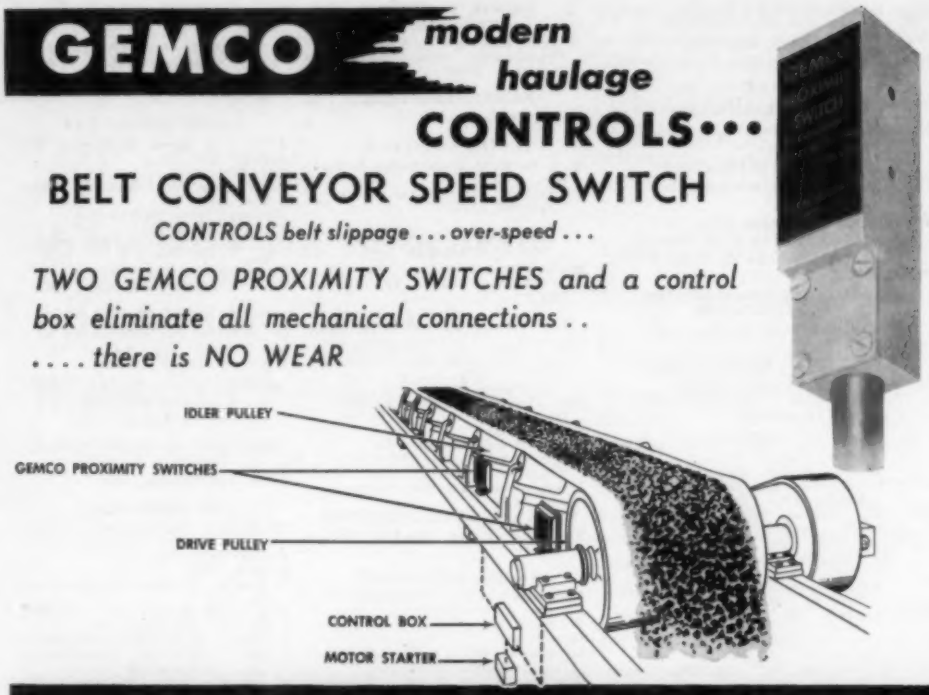

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In surface conveying systems, neoprene's sunlight and weather resistance has also resulted in savings for the coal industry. Neoprene offers the same durability in air hose, V-belts, trailing cable, packings, brattice cloth and ventilating tubing.

Be sure to specify neoprene when you replace your conveyor belting, or buy new equipment. Neoprene's combination of properties means added economy and safety. For additional information, write for "Du Pont Elastomer in Industry," E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Dept., CA-7, Wilmington 98, Del.

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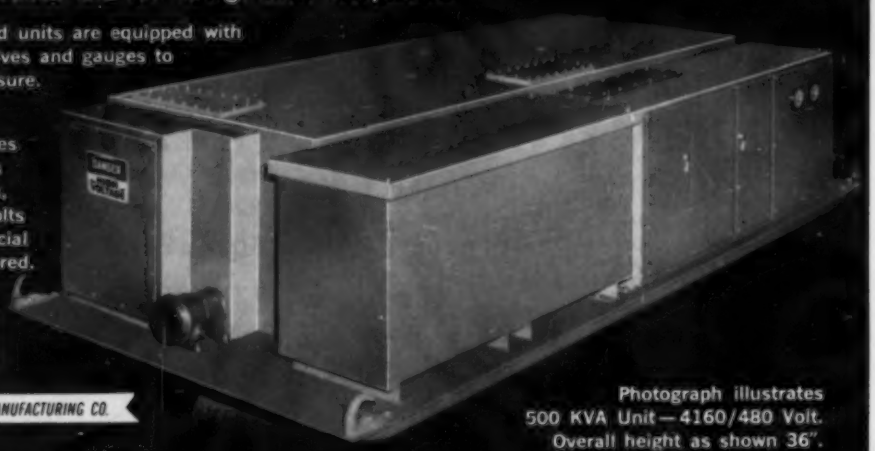

Photograph illustrates 500 KVA Unit—4160/480 Volt. Overall height as shown 36".

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Ampco Metal, Inc.
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Morris Machine Works
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(for other Sun News, read the ad on page 47 of this issue)

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Homelite a div. of Textron, Inc.—"HOMELITE"
Guyan Machy. Co.—"GORMAN RUPP"
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Morse Bros. Machinery Co.
Ore Reclamation Co.
Rice Pump & Machine Co.—"RICE"
Western Machinery Co.—"WEMCO"
Worthington Corp.

PUMPS, DRUM

General Scientific Equipment Co.—"GS"
Gray & Co., Inc.—"DIRECT-FROM-DRUM"
Lincoln Engrg. Co., Div. of McNeil Mach. & Engrg. Co.—"AIRLINE"

PUMPS, FIRE

Allis-Chalmers Mfg. Co.
Flood City Brass & Electric Co.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
Layne & Bowler Pump Co.—"VERTI-LINE"
Porto Pump, Inc.

PUMPS, FROTH HANDLING

Denver Equipment Co.—"DENVER"

PUMPS, HIGH PRESSURE

Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.

PUMPS, HIGH VACUUM

Central Scientific Co.—"CENCO HYVAC"

PUMPS, HORIZONTAL-SHAFT

Nagle Pumps, Inc.

PUMPS, JET

Aurora Pump Div., The New York Air Brake Co.
Barnes Mfg. Co.
Construction Machy. Co.
The Deming Co.
Fairbanks Morse & Co.
The Gorman-Rupp Co.
Goulds Pumps, Inc.
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Lancaster Pump & Mfg. Co.—"DUTCHMAN"
Porto Pump, Inc.

PUMPS, METERING

B-I-F Industries, Inc.
Roots-Connersville Blower, Div. Dresser Industries Inc.

PUMPS, OIL

Canton Stoker Corp.—"WAGENER"

PUMPS, PISTON & PLUNGER

American-Marsh Pumps, Inc.
Canton Stoker Corp.—"WAGENER"
Dean Brothers Pumps Inc.
The Deming Co.
Flood City Brass & Electric Co.
Gardner-Denver Company
Goulds Pumps, Inc.
Guyan Machy. Co.—"MYERS"
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Co.
Lancaster Pump & Mfg. Co.—"GIANT," "LITTLE GIANT"
Ledeen Mfg. Co.
National Mine Service Co.
National Supply Company—"NATIONAL"
Worthington Corp.

PUMPS, PLUNGER

Aldrich Pump Co.

PUMPS, PORTABLE SLUDGE AIR

Herold Mfg. Co.

PUMPS, PRESSURE-TESTING

Porto Pump Inc.

PUMPS, PRIMING

American Crucible Products Co., Kenco Pump Div.

PUMPS, RADIAL PISTON

American Engineering Co.—"HELE-SHAW," "HYRA-MITE"

PUMPS, ROTARY

The Deming Co.
Stenberg Mfg. Corp.—"FLYGT"

PUMPS, ROTARY PISTON GEAR

Kinney Mfg. Div., The New York Air Brake Co.

PUMPS, SAND ABRASIVE HANDLING

Allis-Chalmers Mfg. Co.
Denver Equipment Co.—"DENVER S-R-L"

PUMPS, SOLIDS-HANDLING

Allen-Sherman-Hoff Pump Co.—"HYDROSEAL-CENTRI-SEAL"
Allis-Chalmers Mfg. Co.
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
American-Marsh Pumps, Inc.
Aurora Pump Div., The New York Air Brake Co.
Barnes Mfg. Co.
Barrett Haentjens & Co.
Canton Stoker Corp.—"WAGENER"
Carver Pump Co.
The Deming Co.
Dorr-Oliver Incorporated
Galigher Co.—"VACSEAL"
Goulds Pumps, Inc.
Goyne Pump Co. (horizontal and vertical)
Guyan Machy. Co.—"GORMAN RUPP"
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Lincoln Engrg. Co., Div. of McNeil Mach. & Engrg. Co.
Marlow Pumps, Div. of Bell & Gossett Co.
Meckum Engineering, Inc.
Morris Machine Works
Nagle Pumps, Inc.
Ore Reclamation Co.
Robbins & Myers, Inc.—"MOYNO"
Western Machinery Co.—"WEMCO TORQUE FLOW"
A. R. Wilfley & Sons
Worthington Corp.

PUMPS, SLURRY

Morris Machine Works

PUMPS, SPRAY, HIGH-PRESSURE

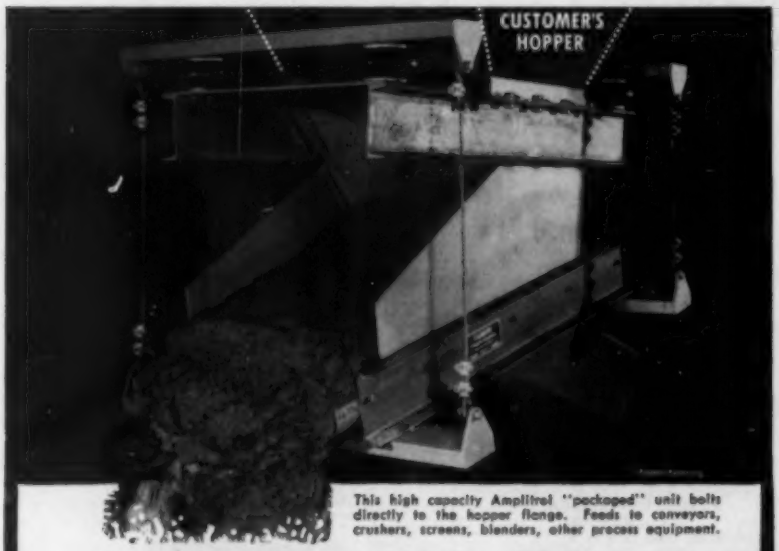
Flood City Brass & Electric Co.

PUMPS, SUBMERSIBLE

American Crucible Products Co., Kenco Pump Div.
Byron Jackson Pumps, Inc., A Sub of Borg-Warner Corp.
The Deming Co.
Guyan Machy. Co.—"REDA"
Lancaster Pump & Mfg. Co.—"EMU"
Layne & Bowler, Inc.—"LAYNE"
Stenberg Mfg. Corp.—"FLYGT"

PUMPS, SUMP

Allen-Sherman-Hoff Pump Co.—"HYDROSEAL"



This high capacity Amplitrol "packaged" unit bolts directly to the hopper flange. Feeds to conveyors, crushers, screens, blenders, other process equipment.

"Feeder-Hopper Bottom Package" Reduces Design, Installation Costs!

For the first time a feeder is offered as part of a complete pre-engineered feeder-hopper bottom package. When you design with Carrier Amplitrol feeders, you merely design a hopper flange to bolt to the packaged unit. *This saves you both engineering design and installation costs!*

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Dean Brothers Pumps Inc.
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Lancaster Pump & Mfg. Co., Inc.
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Aurora Pump Div., The New York Air Brake Co.
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Carver Pump Co.
The Deming Co.
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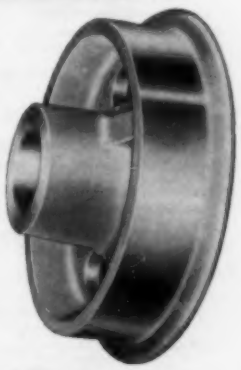

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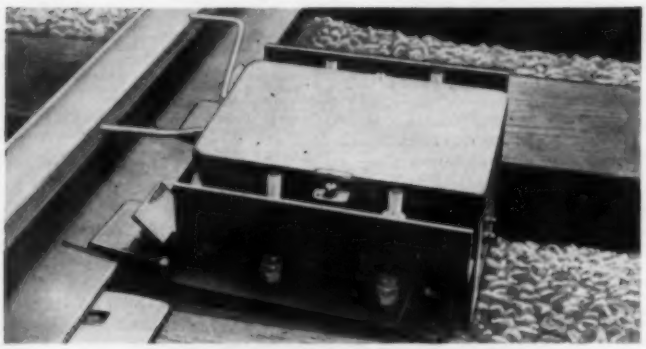

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The Youngstown Sheet and Tube Co.

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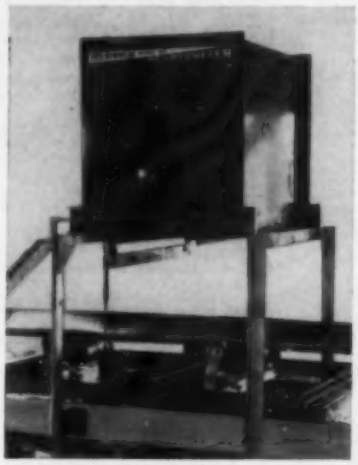

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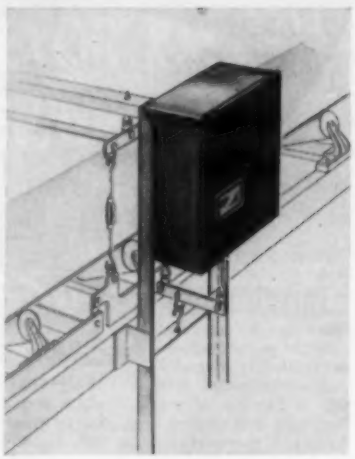

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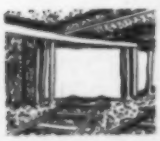

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SHAFT & TUNNEL SUPPORTS

Commercial Shearing & Stamping Co.

SHAFTING, STEEL

Bethlehem Steel Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-59
Joseph T. Ryerson & Son, Inc.
W. J. Savage Co.
Transall Inc.
Bertrand P. Tracy Co.

SHAFTS, SPLINED

North American Machine Co.—"NAMCO"

SHAPERS

South Bend Lathe Works

SHAPES, STRUCTURAL, ALUMINUM

Aluminum Company of America
Robert Holmes & Bros., Inc.
Reynolds Metals Co.

SHEARS, PORTABLE ELECTRIC

Black & Decker Mfg. Co.

SHEAVES, BICYCLE-TYPE

Connellsville Mfg. & Mine Supply Co.

SHEAVES, FABRICATED

Connellsville Mfg. & Mine Supply Co.

SHEAVES, HOISTING

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
C. S. Card Iron Works
Robert Holmes & Bros., Inc.
Kensington Steel, Div. of Poor & Co.
Nordberg Mfg. Co.
Pittsburgh Gear Co.
Sanford Day Iron Works, Inc.
Sauerman Bros., Inc.—"DUROLITE"
The Tool Steel Gear & Pinion Co.
Vulcan Iron Works—"ALL-CASTEEL"
Wilmot Engineering Co.

SHEAVES, TRACK

C. S. Card Iron Works
Robert Holmes & Bros., Inc.
Pittsburgh Gear Co.
Sanford Day Iron Works, Inc.
Sauerman Bros., Inc.—"DUROLITE"

SHEAVES, V-BELT

Allis-Chalmers Mfg. Co.—"TEXROPE"
The American Pulley Co.—"WEDG-TITE"
Boston Woven Hose & Rubber Co., Div. of American Biltrite Co.—"BOSTON"
Browning Mfg. Co.
J. D. Christian Engineers
Continental Gin Co., Ind. Div.
Dayton Industrial Products Co.
Dodge Mfg. Corp.—"TAPER LOCK," "DYNA-V"
Flood City Brass & Electric Co.
The Gates Rubber Co. Sales Div., Inc.
Guyan Machy. Co.
Hewitt-Robins Incorporated—"JONES"
Iowa Mfg. Co.
Link-Belt Co., Dept. CAMGL-59
McLanahan & Stone Corp.
McNally-Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
National Mine Service Co.
Ore Reclamation Co.
Pittsburgh Gear Co.
Transall, Inc.
T. B. Woods Sons Co.—"SURE-GRIP"
Worthington Corp.

SHEAVES, WIRE-ROPE

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
C. S. Card Iron Works
Farrell-Cheek Steel Co.
Robert Holmes & Bros., Inc.
Joy Mfg. Co.
Kensington Steel, Div. of Poor & Co.
Nordberg Mfg. Co.
Pittsburgh Gear Co.
Sanford Day Iron Works, Inc.
Sauerman Bros., Inc.—"DUROLITE"
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
Vulcan Iron Works—"ALL-CASTEEL"
T. B. Woods Sons Co.

SHEET, CORRUGATED ALUMINUM

Aluminum Co. of America

SHELVING, RACKS, ETC.

The Frick-Gallagher Mfg. Co.—"CLIP-BILT"
National Mine Service Co.
Miners' Hardware Supply Co.—"LYONS METAL PRODUCTS"

SHIM STOCK, SHIMS

Crucible Steel Co. of America
B. F. Goodrich Industrial Products Co.

SHOCK ABSORBERS, MACHINE & MOTOR MOUNTS

Continental Rubber Works
Goodyear Tire & Rubber Co.
United States Rubber Co.

SHOTFIRERS

Femco, Inc.
Mine Safety Appliances Co.
National Mine Service Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.

SHOVELS, HAND

Gibraltar Equipment & Mfg. Co.
National Mine Service Co.
The Salem Tool Co.—"RED DEVIL"
The Wood Shovel & Tool Co.

SHOVELS, STANDARD POWER-TYPE, COAL LOADING

American Hoist & Derrick Co.—"AMERICAN"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.—"LIMA"
Bucyrus-Erie Co.
Gar Wood Industries, Inc.
Harnischfeger Corp.
Koehring Div. of Koehring Co.
Link-Belt Speeder Corp.
Marion Power Shovel Co., a Div. of Universal Marion Corp.
Northwest Engineering Co.
Orton Crane & Shovel Co.
"Quick-Way" Truck Shovel Co.
Schield Bantam Co.
The Thew Shovel Co.—"LORAIN"
Unit Crane & Shovel Corp.

SHOVELS, STRIPPING

American Hoist & Derrick Co.—"AMERICAN"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.—"LIMA"
Bucyrus Erie Co.
Harnischfeger Corp.
Koehring Div. of Koehring Co.
Link-Belt Speeder Corp.
Manitowoc Engineering Corp.
Marion Power Shovel Co., a Div. of Universal Marion Corp.
Northwest Engineering Co.
"Quick-Way" Truck Shovel Co.
The Thew Shovel Co.—"LORAIN"

SHOVELS, TRACTOR

Allis-Chalmers Mfg. Co.

SHOVELS, TRACTOR MOUNTED

Eimco Corp.

SHOWER-ROOM EQUIPMENT

Onox, Inc.—"ONOX FOOTMATS, ONOX SKIN-TOUGHENER"
J. A. Zurn Mfg. Div., Zurn Industries, Inc.—"ZURN"

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Herold Mfg. Co.

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Transcontrol Corp.

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Nachod & U.S. Signal Co.
Transcontrol Corp.
Union Switch Signal Div., Westinghouse Air Brake Co.

SIGNALS, LIGHT CASES

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General Equipment & Manufacturing Co.
Nachod & U.S. Signal Co.

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The Neff & Fry Co.
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C. R. Daniels Co.
B. F. Goodrich Co., Industrial Products Div.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Raybestos Manhattan Inc., Manhattan Rubber Div.

SLINGS, CHAIN

American Chain Div., American Chain & Cable Co., Inc.
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Bethlehem Steel Co.
Broderick & Bascom Rope Co.— "YELLOW STRAND," "B & B," "BROLOC," "THRIF-T-LIFT"
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.— "WICKWIRE," "MAXIFLEX," "MULTIFLEX," "UNIFLEX" "DURAGRIP
Electric Steel Foundry Co.
John Flocker & Co.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div., H. K. Porter Co., Inc.
Macwhyte Wire Rope Co.— "ATLAS," "DREW," "MONARCH," "SAFE-GUARD," "SAFE-LOCK"
National Mine Service Co.
John A. Roebling's Sons Corp., Sub. Colorado Fuel & Iron Corp.
Joseph T. Ryerson & Son, Inc.
Union Wire Rope Corp. Sub. of Armco Steel Corp.— "TUFFY"
The Upson-Walton Co.—"MAX-GRIP"
Wire Rope Corp. of America, Inc.—"WIRECO"

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Cambridge Wire Cloth

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SLUSHERS, SCRAPER

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Howells Mining Drill Co.— "HOWELLS"

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Fisher Scientific Co.
General Scientific Equipment Co. —"GS"
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J. D. Christian Engineers
The Falk Corp.—"FALK"
Farrel-Birmingham Co., Inc.
Hewitt-Robins Incorporated— "JONES"
Link-Belt Co., Dept. CAMGL-59
U.S. Electrical Motors, Inc.— "SYNCRO GEAR"
Westinghouse Electric Corp.
Worthington Corp.

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The American Pulley Co.— "SHAFT-KING," "SCREW-KING"
J. D. Christian Engineers— "RITE-LO-SPEED"
Cleveland Worm & Gear Co.— "CLEVELAND," "SPEED-AIRE"
Coal Machinery Research, Inc.
Continental Gin Co., Ind. Div.
Dodge Mfg. Corp.—"TORQUE-ARM"
The Falk Corp.—"FALK"
Farrel-Birmingham Co., Inc.
Foote Brothers Gear & Machinery Corp.—"HYGRADE," "LINE-O-POWER," "MAXI-POWER," "LINE-O-MOUNT" "SHAFT-MOUNT"
Hewitt-Robins Incorporated— "JONES"
Link-Belt Co., Dept. CAMGL-59 —"LINK-BELT," "IN-LINE HELICAL," "PARALLEL SHAFT," "GEAR-MOTOR," "P. I. V." "MOTOGEAR," "UNIVERSAL"
The Master Electric Co., Div. of Reliance Electric & Engr. Co.
Mining Progress, Inc.
Morse Chain Co. A Borg-Warner Industry—"EBERHARDT DENVER"
Ore Reclamation Co.
Stephens-Adamson Mfg. Co.— "SACO"
Sterling Electric Motors, Inc.— "STERLING MULTI-MOUNT"
Transall, Inc.
U. S. Electrical Motors, Inc.— "SYNCROGEAR"
Vickers, Inc., Tulsa Winch Div. —"TULSA"
Westinghouse Electric Corp.
Worthington Corp.

SPEED REDUCERS, WORM

Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-59

SPEED, REDUCERS, WORM GEAR

Cone-Drive Gears Div., Michigan Tool Co.

SPIKE PULLERS

Gibraltar Equipment & Mfg. Co.

SPIKES, TRACK—See Rail Spikes

SPIRALS, COAL

Mining Progress, Inc.
Western Machinery Co.— "WEMCO"

SPLICING COMPOUNDS, MATERIALS—SEE Conveyor Belting Splicing Materials

SPRAY COMPOUNDS

Fuel Process Co.
The Johnson-March Corp.— "COMPOUND MR"

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Ashland Oil & Refining Co.— "ASHLAND PERMATREAT"
Cities Service Oil Co.
Esso Standard Oil Co.—"KOLAY"
Keenan Oil Co.—"KEENOIL 7"
Shell Oil Co.
Socony Mobil Oil Co. Inc.
Standard Oil Co. (Ind.)
Sun Oil Co.—"COAL KOTE"
Texaco, Inc.
Valvoline Oil Co., Div. of Ashland Oil & Refining Co.

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Keenan Oil Co.
Sanford Day Iron Works, Inc.
W. J. Savage Co.

SPRAYING EQUIPMENT, WATER & COMPOUNDS

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Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
The Johnson-March Corp.

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Elastic Stop Nut Corp. of America —"ROLLPIN"

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American Manganese Steel Div., American Brake Shoe Co.,— "AMSCO"
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Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co., Ind. Div.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.—"TAPER LOCK"
Farrell-Cheek Steel Co.
Guyan Machy. Co.
Helmick Foundry-Machine Co.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kensington Steel, Div. of Poor & Co.
Link-Belt Co., Dept. CAMGL-59 —"LINK-BELT," "FLINT RIM," "DOUBLE DUTY," "TAPER LOCK"
McLanahan & Stone Corp.
McNally-Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Mining Machine Parts, Inc.— "MANGALOY"
National Mine Service Co.
North American Machine Co.— "NAMCO"
Ore Reclamation Co.
Penn Machine Co.
W. J. Savage Co.
Taylor-Wharton Co. Div. Harsco Corp.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
Transall, Inc.
Whitney Chain Co., Sub. of Foote Bros. Gear & Machine Corp.
Wilmot Engineering Co.

SPROCKETS, CAST-IRON

Link-Belt Co., Dept. CAMGL-59
Webster Mfg., Inc.

SPROCKETS, COAL CUTTERS

Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-59
Frank Prox Company, Inc.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.

SPROCKETS, CUT-TOOTH

Link-Belt Co., Dept. CAMGL-59

SPROCKETS, ROLLER CHAIN

Flood City Brass & Electric Co.
Link-Belt Co., Dept. CAMGL-59
Morse Chain Co., A Borg-Warner Industry

SPROCKETS, SILENT CHAIN

Link-Belt Co., Dept. CAMGL-59
Morse Chain Co., A Borg-Warner Industry

SPROCKETS, TAPER-BORE

Link-Belt Co., Dept. CAMGL-59

SPROCKETS, TIMING-BELT

Morse Chain Co., A Borg-Warner Industry

STACKERS, RECLAIMERS, COAL

Barber-Greene Co.
Dravo Corp.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-59
Pioneer Engineering Div. of Poor & Co.
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.

STAIR TREADS

Blaw-Knox Co., Blaw-Knox Equipment Div.
Dravo Corp.
General Scientific Equipment Co. —"GS"
Jones & Laughlin Steel Corp.— "JAL-TREAD," "JUNIOR JAL-TREAD"
Joseph T. Ryerson & Son, Inc.

STARTERS—SEE Motor Controllers, Starters

STEAM GENERATORS

Clayton Mfg. Co.—"CLAYTON"

STEAM TRACED RIPE, ALUMINUM

Aluminum Co. of America— "UNITRACE"

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American Manganese Steel Div., American Brake Shoe Co.— "AMSCO"
American Steel & Wire Div., U.S. Steel Corp.
Bethlehem Steel Co.
A. M. Byers Co.—"BYLOY W-2"
Crucible Steel Co. of America
Electric Steel Foundry Co.
Jones & Laughlin Steel Corp.— "JALLOY"
Kanawha Mfg. Co.
Republic Steel—"REPUBLIC"
Stulz-Sickles Co.—"MANGANAL," "SS HI-C HARD-PLATE"
Taylor-Wharton Co., Div., Harsco Corp.
United States Steel Corp.— "USS A-R"
The Youngstown Sheet and Tube Co.

STEEL, ALLOY

American Manganese Steel Div., American Brake Shoe Co.— "AMSCO"
American Steel & Wire Div., U.S. Steel Corp.
Bethlehem Steel Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.
Crucible Steel Co. of America
Electric Steel Foundry Co.
Jones & Laughlin Steel Corp.— "JALLOY"
Kanawha Mfg. Co.
Lukens Steel Co.—"LUKENS," "T-1"
Republic Steel—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
Sheffield Div., Armco Steel Corp.
Stulz-Sickles Co.
The Timken Roller Bearing Co.
United States Steel Corp.— "USS CARILLOY," "USS T-1," "USS FC," "USS SUPERKORE"
The Youngstown Sheet and Tube Co.

STEEL, ALLOY, FREE MACHINING

Crucible Steel Co. of America

STEEL, CARBON

American Steel & Wire Div., U.S. Steel Corp.
Bethlehem Steel Co.
Crucible Steel Co. of America
Colorado Fuel & Iron Corp.— "C F & I"
Inland Steel Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Lukens Steel Co.—"LUKENS"
Phoenix Steel Corp., Structural & Tube Divs.
Republic Steel—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
Sheffield Div., Armco Steel Corp.
United States Steel Corp.
The Youngstown Sheet and Tube Co.

STEEL, CAST CORROSION-RESISTANT

Electro-Alloys Div., American Brake Shoe Co.

STEEL, CAST HEAT-RESISTANT ALLOY

Electro-Alloys Div., American Brake Shoe Co.

STEEL, CLAD

Lukens Steel Co.—"LUKENS"

STEEL, CORROSION-RESISTANT

Allegheny Ludlum Steel Corp.
Crucible Steel Co. of America
Electro-Alloys Div. American Brake Shoe Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Republic Steel—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
The Youngstown Sheet and Tube Co.

STEEL, GALVANIZED

Inland Steel Co.—"TM-TI-CO"

STEEL, HEAT RESISTANT ALLOY

Electro-Alloys Div., American Brake Shoe Co.

STEEL, HIGH-STRENGTH

American Steel & Wire Div., U.S. Steel Corp.
Bethlehem Steel Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.
Crucible Steel Co. of America
Inland Steel Co.—"TM-HI-STEEL," 'HI-MAN"
Jones & Laughlin Steel Corp.—"JALTEN"
Kanawha Mfg. Co.
Republic Steel—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
Sheffield Div., Armco Steel Corp.
Stulz-Sickles Co.
United States Steel Corp.—"USS CORTEN," "USS MAN-TEN," "USS TRI-TEN"

STEEL, HIGH-STRENGTH, LOW-ALLOY

The Youngstown Sheet and Tube Co.

STEEL, NICKEL

Lukens Steel Co.—"LUKENS LINE"

STEEL, REINFORCING

Bethlehem Steel Co.

STEEL, SPECIAL SECTIONS

H. K. Porter Co., Connors Steel Div.

STEEL, STAINLESS

Allegheny Ludlum Steel Corp.—"ALLEGHENY"
American Steel & Wire Div., U.S. Steel Corp.
Colorado Fuel & Iron Corp.
Crucible Steel Co. of America
Disston Div., H. K. Porter Co., Inc.
Electric Steel Foundry Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Republic Steel—"REPUBLIC ENDURO"
Joseph T. Ryerson & Son, Inc.
United States Steel Corp.

STEEL, STRUCTURAL

Arrowhead Engineers and Constructors, Inc.
Colorado Fuel Iron Corp.—"C F & I"
Bethlehem Steel Co.
Dravo Corp.
Robert Holmes & Bros., Inc.
Inland Steel Co.
Jones & Laughlin Steel Corp.—"JUNIOR BEAMS," "JUNIOR TEES," "JUNIOR CHANNELS"
Kanawha Mfg. Co.
Phoenix Steel Corp., Structural & Tube Divs.
H. K. Porter Co., Connors Steel Div.
Joseph T. Ryerson & Son, Inc.
Sheffield Div., Armco Steel Corp.
United States Steel Corp.

STEEL, TOOL

Allegheny Ludlum Steel Corp.—"ALLEGHENY LUDLUM"
Bethlehem Steel Co.
Crucible Steel Co. of America—"REX"
Jones & Laughlin Steel Corp.
Republic Steel—"REPUBLIC"
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Laclede Stoker Co.—"LACLEDE 'F' TYPE," "LACLEDE 'L' TYPE"

STOKERS, SPREADER

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Combustion Engineering, Inc.—"C-E"
Dayton Automatic Stoker Co.
Hoffman Combustion Engrg. Co.—"FIRITE"
Laclede Stoker Co.—"LACLEDE-UNIVERSAL"

STOKERS, TRAVELING GRATE

Combustion Engineering, Inc.—"C-E"

STOKERS, UNDERFEED

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Carpenter Heating & Air Conditioning Co.—"CARPENTER"
Combustion Engineering, Inc.—"C-E"
Dayton Automatic Stoker Co.—"MARINE"

STOKERS, VIBRATING GRATE

American Engineering Co.—"VIBRA-GRATE"

STOPERS, ROOF-BOLTING

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Gardner-Denver Company
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.—"VAC-NUMATIC"
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STOPPINGS, STEEL DEMOUNTABLE

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STORAGE PILE PROTECTIVE COATING

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STORAGE SYSTEMS, COAL

Link-Belt Co., Dept. CAMGL-59

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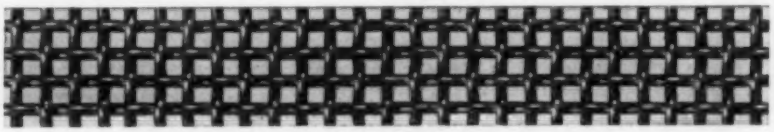

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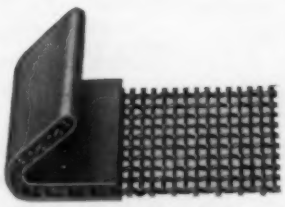

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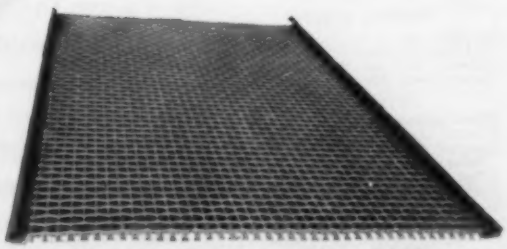
Tyler Screen Sections are furnished for all makes of vibrating screens in all meshes and metals. Each section is fabricated with the right type of edge or hook strip for the specification of screen cloth and to fit the particular make and model of screening machine on which it will be used.



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CLEVELAND 14, OHIO
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General Electric Co., Apparatus Sales Div.
I-T-E Circuit Breaker Co.
Westinghouse Electric Corp.

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General Electric Co., Apparatus Sales Div.
I-T-E Circuit Breaker Co.
Westinghouse Electric Corp.

SUGGESTION SYSTEMS, POSTERS, BOXES, FORMS
Elliott Service Co., Inc.

SUPERVISORY-CONTROL SYSTEMS
B-I-F Industries, Inc.—"SYNCHRO-SCAN," "TONE LINK"
The Bristol Co.—"METAMETER TELEMETERING"
Femco, Inc.
Industrial Physics & Electronics Co.
General Electric Co., Apparatus Sales Div.

SURVEY MARKERS
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"

SURVEYING EQUIPMENT
C. L. Berger & Sons, Inc.—"BERGER"
Charles Bruning Co., Inc.
The Geodimeter Co.—"GEODIMETER"
Geo-Optic & Paper Corp.
Gurley, W. & L. E.
Wild Heerbrugg Instruments, Inc.

SUSPENSION, FEEDER
The Elreco Corp.

SWEATBANDS
American-Optical Co. Safety Products Div.
Pulmosan Safety Equip. Co.

SWEEPERS, MINE CLEAN-UP
J. H. Fletcher & Co.

SWITCHBOARDS
Allis-Chalmers Mfg. Co.
Cutler Hammer Inc.
General Electric Co., Apparatus Sales Div.
I-T-E Circuit Breaker Co.
Ironton Engine Co.—"IRONTON"
Joy Mfg. Co.
Mosebach Electric & Supply Co.
Westinghouse Electric Corp.

SWITCH BOXES
Joy Mfg. Co.
Mosebach Electric & Supply Co.
National Electric Products Co.
Westinghouse Electric Corp.

SWITCHGEAR
Allis-Chalmers Mfg. Co.
Electric Machinery Mfg. Co.
General Electric Co., Apparatus Sales Div.
I-T-E Circuit Breaker Co.
Herbert S. Littlewood
Westinghouse Electric Corp.

SWITCHGEAR, PORTABLE, SHOVEL CABLES
Atkinson Armature Co.

SWITCH HOUSES
Allis-Chalmers Mfg. Co.
Mosebach Electric & Supply Co.
Westinghouse Electric Corp.

SWITCHERS, RR CAR
LeTourneau-Westinghouse Co.—"SWITCH MOBILE" "SWITCH-TRACTOR"

SWITCHES, AIR FLOW CONTROLLED MERCURY TUBE
Guyan Machy. Co.

SWITCHES, AUTOMATIC
The Nolan Co.

SWITCHES, BELT CONTROL
General Equipment & Manufacturing Co.
Schroeder Brothers Corp.

SWITCHES, CENTRIFUGAL
Ensign Electric & Mfg. Co.

SWITCHES, CONTROL, MOTORMAN OPERATED
Cheatham Electric Switching Device Co.
General Equipment & Manufacturing Co.
Nachod & U. S. Signal Co.
Transcontrol Corp.

SWITCHES, CONVEYOR-BELT STOP
Cheatham Electric Switching Device Co.

SWITCHES, CONVEYOR-CONTROL
General Electric Co., Apparatus Sales Div.
Joy Mfg. Co.
Westinghouse Electric Corp.

SWITCHES, ELECTRIC HAND
American Mine Door Co.
Cheatham Electric Switching Device Co.
General Equipment & Manufacturing Co.
Nachod & U. S. Signal Co.

SWITCHES, ELECTRICAL
Arrow Hart & Hegeman Electric Co.—"QUIETTE"
Circuit Protective Devices Dept., General Electric Co.
Clark Controller Co.
Crouse-Hinds Co.
Cutler-Hammer, Inc.—"C-H"
The Elreco Corp.—"POWER"
G & W Electric Specialty Co.
General Electric Co., Apparatus Sales Div.
I-T-E Circuit Breaker Co.
Joy Mfg. Co.
Ohio Brass Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Stackpole Carbon Co.
Westinghouse Electric Corp.

SWITCHES, ELECTRICAL, SAFETY
Arrow Hart & Hegeman Electric Co.
Circuit Protective Devices Dept., General Electric Co.
Crouse-Hinds Co.
Cutler-Hammer, Inc.—"C-H"
Dooley Brothers
General Electric Co., Apparatus Sales Div.
Joy Mfg. Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.
Westinghouse Electric Corp.

SWITCHES, LIMIT
General Equipment & Manufacturing Co.

SWITCHES, LOCOMOTIVE TRANSFER
Circuit Protective Devices Dept., General Electric Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Jeffrey Mfg. Co.
The Post Glover Electric Co.—"P-G"

SWITCHES, MERCURY
Crouse-Hinds Co.
Durakool, Inc.
Joy Mfg. Co.
The Post Glover Electric Co.—"P-G"

SWITCHES, OUTDOOR HOOK STICK
Delta-Star Electric Div., H. K. Porter Co., Inc.

SWITCHES, PRESSURE
Barksdale Valves—"BARKSDALE-MELETRON"

SWITCHES, ROPE-PULL MOMENTARY
American Mine Door Co.
Cheatham Electric Switching Device Co.
General Equipment & Manufacturing Co.

SWITCHES, THERMOCOUPLE
West Instrument Corp.

SWITCHTHROWERS
See Rail Switchthrowers

TABLE DECKS, WASHING
Linatex Corp. of America

TABLES, AIR-CLEANING
Fairmont Machinery Co.
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.—"SUPER-AIRFLOW"

TABLES, COAL-WASHING
The Daniels Co., Contractors, Inc.
The Deister Concentrator Co., Inc.—"SUPER DUTY DIAGONAL DECK," "CONCENCO '77' DIAGONAL DECK"
Deister Machine Co.
Link-Belt Co., Dept. CAMGL-59

TABLES, DRAFTING
Charles Bruning Co. Inc.

TACHOMETERS
The Bristol Co.—"BRISTOL'S"
Fisher Scientific Co.
Foxboro Co.
General Electric Co., Apparatus Sales Div.
Ideal Industries, Inc.
Martindale Electric Co.
Minneapolis-Honeywell Regulator Co., Industrial Division
Stewart-Warner Corp., Alemite Div.
Westinghouse Electric Corp.

TAKEOFFS, POWER
Gar Wood Industries, Inc.
Schroeder Brothers Corp.
Twin Disc Clutch Co.
Vickers, Inc., Tulsa Winch Div. —"TULSA"

TAKEOFFS, POWER, SPLIT SHAFT TYPE
Hendrickson Mfg. Co.

TAKEUPS, BALL, ROLLER
Dodge Mfg. Corp.
Link-Belt Co., Dept. CAMGL-59

TAKEUPS, CONVEYOR
Barber-Greene Co.
Bearings, Inc.
Chain Belt Co., Shafer Bearing Div.—"SHAFER SELF-ALIGNING"
J. D. Christian Engineers
Goodman Mfg. Co.
Hewitt-Robins, Incorporated
Irwin-Sensenich Corp.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-59
McNally-Pittsburg Mfg. Corp.
Pioneer Engineering, Div. of Poor & Co.
Roberts & Schaefer Co., Div Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.

TAKEUP UNITS, BALL-BEARING
Link-Belt Co., Dept. CAMGL-59

TAKEUP UNITS, SPHERICAL ROLLER BEARING
Link-Belt Co., Dept. CAMGL-59

TAMPERS, MINE TRACK
J. H. Fletcher & Co.

TAMPERS, PNEUMATIC
Schroeder Brothers Corp.

TAMPERS, SHOTHOLE
The Leetonia Tool Co.

TAMPING BAGS—See Bags, Tamping

TAMPING PLUGS
Charles Abbott & Associates—"TRUBLAST RAPID STEMMING PLUG"
National Mine Service Co.

TAMPING POLES, HEADS
The Salem Tool Co.—"McCARTHY"

TAMPING STICKS, WOOD
Duquesne Mine Supply Co.
J. V. Hammond Co.
National Mine Service Co.
National Powder Co.
The Salem Tool Co.—"BLACK DIAMOND"

TANK-LEVEL CONTROLS
Industrial Nucleonics Corp.—"ACCURAY"

TANKS, CLARIFYING, SLUDGE RECOVERY
Fairmont Machinery Co.
Denver Equipment Co.—"DENVER"
Eagle Iron Works
Link-Belt Co., Dept. CAMGL-59
Peterson Filters & Engineering Co.
K. Prins & Associates
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.

TANKS, PLASTIC-LINED
Galigher Co.

TANKS, RUBBER-LINED
Denver Equipment Co.—"DENVER"
Galigher Co.
The Gates Rubber Co. Sales Div., Inc.
B. F. Goodrich Industrial Products Co.
Linatex Corp. of America
Thermoid Div., H. K. Porter Co.
Raybestos Manhattan Inc., Manhattan Rubber Div.
United States Rubber Co.

TANKS, STEEL
Bethlehem Steel Co.
The Daniels Co., Contractors, Inc.
Denver Equipment Co.—"DENVER"
Enterprise Wheel & Car Corp.
Robert Holmes & Bros., Inc.
Kanawha Mfg. Co.
Koven Fabricators, Inc.
Phoenix Steel Corp., Structural & Tube Divs.
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.
W. J. Savage Co.

TANKS, WOOD
Denver Equipment Co.—"DENVER"
The Hauser-Stander Tank Co.

TAPE, ADHESIVE
Johns-Manville—"DUTCH BRAND"

TAPE, ALUMINUM FOIL
Minnesota Mining & Mfg. Co.—"SCOTCH BRAND NO. 49"

TAPE, BONDING
B. F. Goodrich Industrial Products Co.

TAPE, COATED, POLYESTER MAT
Irvington Div. of Minnesota Mining & Mfg. Co.—"FIBRE-MAT"

TAPE, ELECTRICAL, PLASTIC
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BULL DOG"
Continental Rubber Works
Dayton Industrial Products Co.—"HOL-FAST"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Johns-Manville—"JOMANCO"
Minnesota Mining & Mfg. Co.—"SCOTCH BRAND NO. 33, 22, 21 & 20"
National Mine Service Co.
Okonite Co.
Plymouth Rubber Co.—"SLIP-KNOT"
United States Rubber Co.

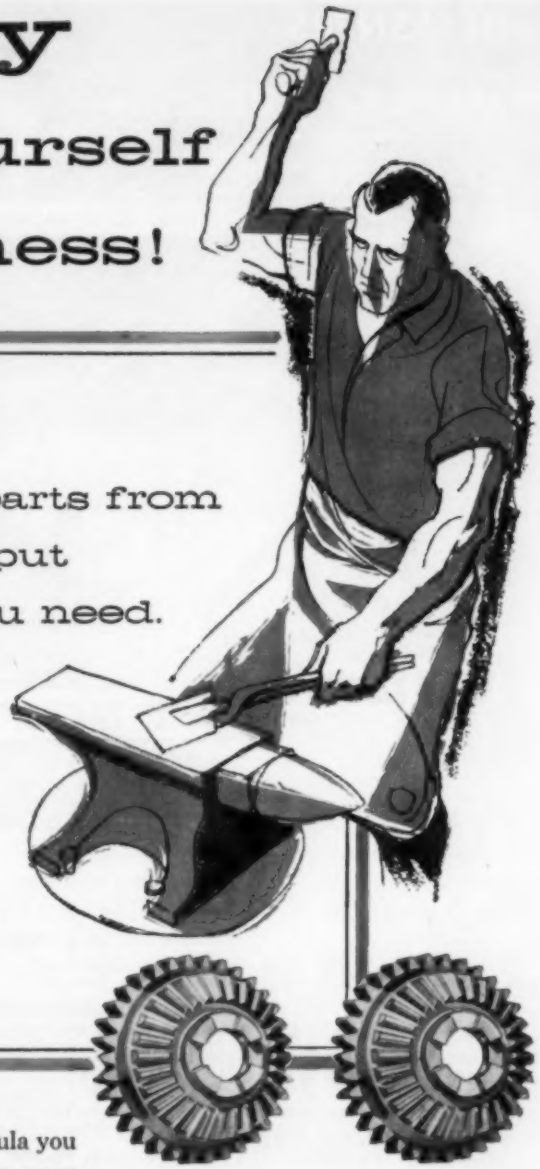
TAPE, ELECTRICAL, GLASS-CLOTH
Minnesota Mining & Mfg. Co.—"SCOTCH BRAND NO. 27"

TAPE, ELECTRICAL, THERMOSETTING
Minnesota Mining & Mfg. Co.—"SCOTCH BRAND"

TAPE, FRICTION
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BULL DOG"
Continental Rubber Works
Dayton Industrial Products Co.—"HOLFAST"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Guyan Machy. Co.
Jenkins Bros.
Johns-Manville—"4-STAR"
Mosebach Electric & Supply Co.
National Electric Co. Div. of McGraw-Edison Co.

Easy Way

To Save Yourself Out of Business!



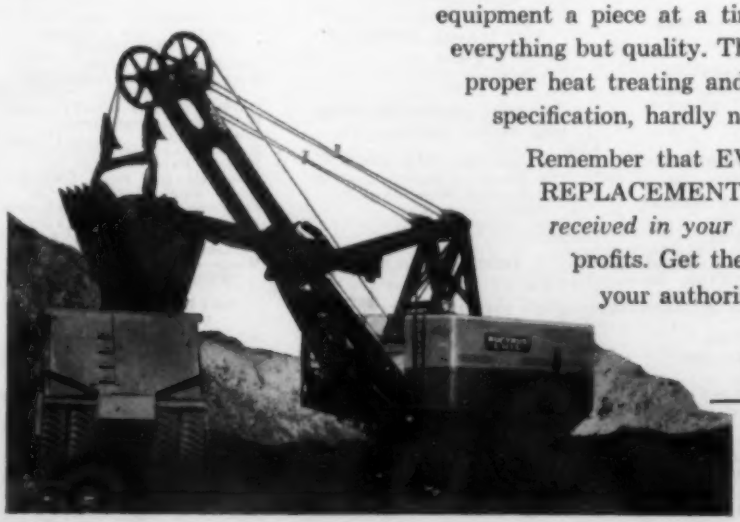
LESSON No. 1:

Buy all replacement parts from the "'smithy." He can put together whatever you need.

All parts you buy from him will be a nickel cheaper than those you buy from the authorized dealer.

The "'smithy" has been hounding you for business . . . give him a break.

The "'smithy" can give you spare parts that look just like the real thing. Same color, same size.

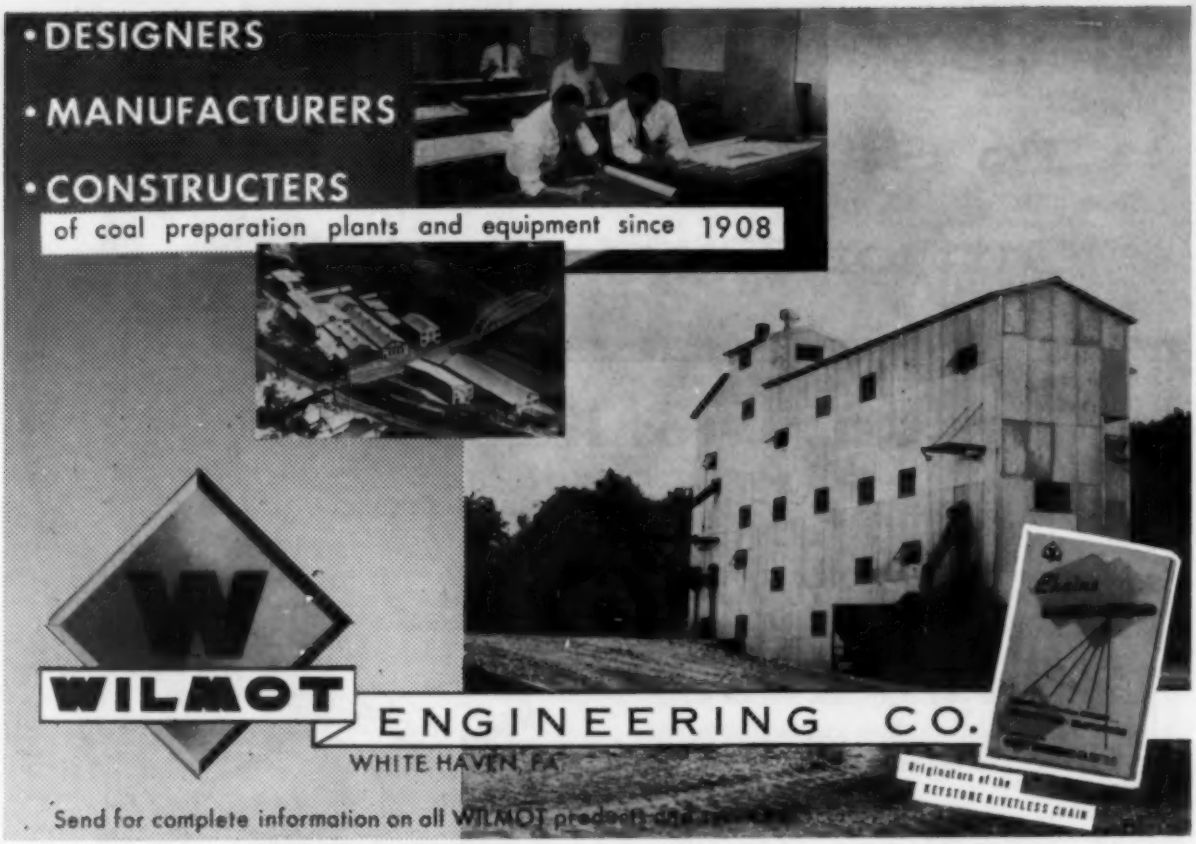


That's the surest formula you can find for selling your equipment a piece at a time, too. The "'smithy" can reproduce everything but quality. The kind of quality you need comes from proper heat treating and flame hardening, proper metallurgical specification, hardly noticeable special shaping of every part.

Remember that EVERY GENUINE BUCYRUS-ERIE REPLACEMENT PART is the *same high quality as you received in your new machine.* Don't gamble with your profits. Get the *right* parts when you need them from your authorized Bucyrus-Erie distributor.

BUCYRUS ERIE®

Builds Better Equipment



National Mine Service Co.
Okonite Co.
Plymouth Rubber Co., Inc.—"SLIPKNOT"
The Ruberoid Co.
Thermoid Div., H. K. Porter Co., Inc.
United States Rubber Co.
West Virginia Armature Co.

TAPE, GLASS-CLOTH

Johns-Manville
National Electric Coil Div. of McGraw-Edison Co.—"MICA-GLAS"

TAPE, GLASS-CLOTH, COATED

Irvington Div. of Minnesota Mining & Mfg. Co.—"FIBRE-MAT"

TAPE, INSULATING, IRRADIATED POLYETHYLENE

General Electric Co., Chemical & Metallurgical Div., Insulating Materials Dept.—"V-C IRRATHANE, MICAMAT"

TAPE, OZONE-RESISTANT

Plymouth Rubber Co., Inc.—"PLYMOZONE"

TAPE, PAPER

Minnesota Mining & Mfg. Co.—"SCOTCH"

TAPE, PLASTIC

Jenkins Bros.

TAPE, POLYETHYLENE

Dayton Industrial Products Co.—"HOLFAST"

TAPE, RUBBER

Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BULL DOG"
Continental Rubber Works
Dayton Industrial Products Co.—"HOLFAST"
Goodall Rubber Co.
Jenkins Bros.
Johns-Manville—"DUTCH BRAND"
Mosebach Electric & Supply Co.
National Electric Coil Div. of McGraw-Edison Co.
National Mine Service Co.
Okonite Co.
Plymouth Rubber Co., Inc.—"P. R."
Thermoid Div., H. K. Porter Co. Inc.
United States Rubber Co.
West Virginia Armature Co.

TAPE, VARNISHED-CAMBRIC

Irvington Div. of Minnesota Mining & Mfg. Co.
National Electric Coil Div. of McGraw-Edison Co.
Minnesota Mining & Mfg. Co.—"IRVINGTON," "FIBREMAT," "IVY-BIND," "IRVINGTON" (arc-proofing tapes & blankets)

TAPE, VINYL PLASTIC

Dayton Industrial Products Co.—"HOLFAST"

TAPE, VULCANIZING

American Mine Door Co.

TAPES, MEASURING

Charles Bruning Co., Inc.
Disston Div., H. K Porter Co, Inc.
Lufkin Rule Co.

TAPPERS, PORTABLE

Black & Decker Mfg. Co.

TAPS, CABLE & TROLLEY, FUSED

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Mining Machine Parts, Inc.—"MMP JABCO"
Mosebach Electric & Supply Co.
Ohio Brass Co.
Standard Devices Co.

TARPAULINS

C. R. Daniels Co.
Fulton Cotton Mills

TELEPHONES, BATTERY

Crouse-Hinds Co.

TELEPHONES, SOUND-POWERED

Crouse-Hinds Co.
Mining Progress, Inc.

TELEPHONES, TROLLEY

Femco, Inc.

TELEVISION SYSTEMS

Diamond Power Specialty Co.—"UTILISCOPE," "UTILIVUE"

TEMPERATURE INDICATORS, CONTROLLERS

B-I-F Industries, Inc.—"CHRONOFLO"
The Bristol Co.—"BRISTOL'S"
Fischer & Porter Co.
Fisher Scientific Co.
Foxboro Co.
General Electric Co. Apparatus Sales Div.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division—"GUARDSMAN-VERI-TELL"
West Instrument Corp.
Westinghouse Electric Corp.

TEST STANDS, HYDRAULIC

Fischer & Porter Co.
Schroeder Brothers Corp.—"UNIVERSAL"

TESTERS, CARBON MONOXIDE

Mine Safety Appliances Co.

TESTERS, INSULATION

The Electrical Distributors Co.
The Hewson Co.—"TAKK," "VON"
Ideal Industries, Inc.
Martindale Electric Co.

TESTERS, INSULATORS

I-T-E Circuit Breaker Co.

TESTERS, PORTABLE HYDRAULIC

Schroeder Brothers Corp—"PT-50-B"

TESTERS, RAIL-BOND

Mosebach Electric & Supply Co.

TESTERS, RAIL-BOND, INSULATED HANGERS

Ohio Brass Co.

TESTERS, VOLTAGE

Fisher Scientific Co.
General Electric Co., Apparatus Sales Div.
Holub Industries, Inc.
I-T-E Circuit Breaker Co.
Ideal Industries, Inc.
Martindale Electric Co.
Westinghouse Electric Corp.

THEODOLITES

W. & L. E. Gurley

THEODOLITES, OPTICAL MINING

Kern Instruments, Inc.

THERMOCOUPLES

The Bristol Co.—"BRISTOL'S"
Foxboro Co.
General Electric Co., Apparatus Sales Div.
Minneapolis-Honeywell Regulator Co., Industrial Division
West Instrument Corp.

THICKENERS

American Well Works
Denver Equipment Co.—"DENVER-STANDARD," "DENVER HEAVY-DUTY AUTOMATIC"
Dorr-Oliver, Incorporated
Eimco Corp.
Hardinge Co., Inc.
Heyl & Patterson, Inc.
Link-Belt Co., Dept. CAMGL-59
Morse Bros. Machinery Co.
Peterson Filters & Engineering Co.
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.
Western Machinery Co.—"WEMCO"

THICKENING, STABILIZING, SUSPENDING AGENTS

B. F. Goodrich Chemical Co.—"GOOD-RITE CARBOPAL 934"

THINNERS, INSULATING PAINT, VARNISH

General Electric Co., Chemical & Metallurgical Div., Insulating Materials Dept.

THROTTLE CONTROLS

Link-Belt Speeder Corp.—"SPEED-O-TROL"

TIES, CROSS, SWITCH
Republic Creosoting Co.

TIMBER—See also Roof Supports, Yieldable Arch

TIMBER, PRESSURE-CREOSOTED
Koppers Co., Inc. Wood Preserving Div.

TIMBER, TREATED
Koppers Co., Inc., Wood Preserving Div.—"WOLMANIZED"
Osmose Wood Preserving Co.

TIMBER, TREATED, UNTREATED
T. J. Moss Tie Co.

TIMBER, YIELDING STEEL PROPS
Mining Progress, Inc.
T. J. Moss Tie Co.

TIMBER FRAMERS
Denver Equipment Co.—"DENVER"
Stearns-Roger Mfg. Co.

TIMBER PULLERS
Penn Machine Co.
Templeton, Kenly & Co.—"SIMPLEX"

TIMBER-TREATING MATERIALS
Darworth, Inc., Chemical Products Div.—"CUPRINOL"
The Dow Chemical Co.
Monsanto Chemical Co.
T. J. Moss Tie Co.
Osmose Wood Preserving Co.—"OSMOSALTS, OSMOPLASTICS, M-T-M"

TIMBERING MACHINES
Goodman Mfg. Co.
Ruger Equipment, Inc.—"RUGER TIMBERLIFT"

TIMERS, MERCURY
Durakool, Inc.
Joy Mfg. Co.

TIRE RECAPPING, REPAIRING
Automatic Vulcanizers Corp.

TIRE RECAPPING, REPAIRING, EARTHMOVER
Carolina Tire Co.

TIRES, EARTHMOVER, ON THE JOB SERVICE
Carolina Tire Co.

TIRES, MINE
Mitchell Industrial Tire, Inc.—"MITCO TROUBLE FREE"

TIRES, RUBBER
Dayton Industrial Products Co.—"THOROBRED"
The Gates Rubber Co. Sales Div., Inc.
B. F. Goodrich Tire Co., a Div. of The B. F. Goodrich Co.
Goodyear Tire & Rubber Co.
United States Rubber Co.
W. Va. Belt Repairs, Inc.—"MITCO INDUSTRIAL"

TIRES, STEEL
National Mine Service Co.
Bertrand P. Tracy Co.

TIRES, STEEL TURNING
Leman Machine Co.

TOOLS, ELECTRICAL-CONNECTOR
Burndy Corp.—"HYTOOLS," "HYPRESSES"
Erico Products, Inc.—"CADWELD"
Joy Mfg. Co.

TOOLS, HAND
Guyan Machy Co.—"PROTO," "CHALLENGER"
Proto Tool Co., Div. of Pendleton Tool Industries, Inc.

TOOLS, HAND, SPARK-RESISTING
Ampco Metal, Inc.

TOOLS, MECHANICS
Bearings, Inc.
Disston Div., H. K. Porter Co., Inc.
Genesco Tools Div., General Steel Warehouse Co., Inc.
Snap-on Tools Corp.

TOOLS, PORTABLE, AIR
Chicago Pneumatic Tool Co.
Ensign Electric & Mfg. Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Marathon Coal Bit Co., Inc.—"BUCKEYE"
Penn Machine Co.
Schramm, Inc.
Schroeder Brothers Corp.
Snap-on Tools Corp.
Thor Power Tool Co.
Worthington Corp.

TOOLS, PORTABLE, ELECTRICAL
Black & Decker Mfg. Co.
Chicago Pneumatic Tool Co.
Ensign Electric & Mfg. Co.
Ingersoll-Rand Co.
Martindale Electric Co.
Penn Machine Co.
Joseph T. Ryerson & Son, Inc.
Snap-on Tools Corp.
Syntron Co.
Thor Power Tool Co.

TOOLS, POWDER-POWERED
Mine Safety Appliances Co.—"VELOCITY-POWER"
Remington Arms Co., Inc.—"REMINGTON STUD DRIVER"

TOOLS, TRACK
The Aldon Co.
Gibraltar Equipment & Mfg. Co.—GEMCO TRU-BLU"
The Leetonia Tool Co.

TORQUE CONVERTERS
Clark Equip. Co., Automotive Div.—"CLARK-TORCON"
National Supply Company—"NATIONAL"
Transmission and Axle Div., Rockwell-Standard Corp.
Twin Disc Clutch Co.

TOWBOATS
Dravo Corp.
Marietta Manufacturing Co.

TOWERS, BARGE-UNLOADING
Dravo Corp.
Heyl & Patterson, Inc.
Link-Belt Co., Dept. CAMGL-59
Roberts & Schaefer Co, Div. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.

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THE TREND toward super power and super capacity in machinery calls for SUPER RESISTORS to keep breakdowns at a minimum.

The GUYAN design takes full advantage of the space available in the resistor compartment to build a resistor of proper electrical resistance and high current capacity. The terminals are of heavy cast bronze, clamp type for rigid connections. And they are easily accessible and plainly stamped corresponding to the terminal markings on the original wiring diagram.

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FIRE-RESISTANT
MINESAFE
HYDRAULIC FLUID

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SUNOCO®

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TOWERS, HYDRAULIC
Mobile Aerial Towers, Inc—"HI-RANGER"

TOWERS, LOADING
Link-Belt Co., Dept. CAMGL-59

TRACK BRACES
Gibraltar Equipment & Mfg. Co.

TRACK CLEANERS
American Mine Door Co.—"CANTON"

TRACK SHOES, POWER SHOVEL
American Steel Foundries—"WEARPACT"

TRACKWORK
H. K. Porter Co., Connors Steel Div.

TRACTOR-COMPRESSOR UNITS
Le Roi Div, Westinghouse Air Brake Co.—"TRACTAIR"

TRACTOR GROUSER BARS
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"

TRACTOR GROUSERS
American Steel Foundries—"WEARPACT"

TRACTOR POWER CONTROL UNITS
Le Tourneau-Westinghouse Co.

TRACTOR RAIL & GROUSERS, MANGANESE
Kensington Steel, Div. of Poor & Co.

TRACTOR SPROCKET RIMS, MANGANESE
Kensington Steel, Div. of Poor & Co.

TRACTORS, CRAWLER
Allis-Chalmers Mfg. Co.
J. I. Case Co—"CASE-TERRATRAC"
Caterpillar Tractor Co.
Diesel Energy Corp.
Eimco Corp.
General Motors Corp., Euclid Division
International Harvester Co., Construction Equipment Div.
The Oliver Corp.—"OLIVER"
R. H. Sheppard Co., Inc.

TRACTORS, CRAWLER, UNDERGROUND
Allis-Chalmers Mfg. Co.
Caterpillar Tractor Co.
Eimco Corp.
International Harvester Co., Construction Equipment Div.
Joy Mfg. Co

TRACTORS, DOZER
Allis-Chalmers Mfg. Co.
Clark Equipment Co., Construction Machinery Div.—"MICHIGAN"

TRACTORS, RUBBER-TIRED MINE
Allis-Chalmers Mfg. Co.
Fred's Welding Service
Kersey Manufacturing Co., Inc.
The Long Co.
Motor Exchange and Supply Co.

TRACTORS, TRUCK HAULAGE
Autocar Div., The White Motor Co.
FWD Corp.
Henrickson Mfg. Co.
International Harvester Co., Construction Equipment Div.
KW-Dart Truck Co.
LeTourneau-Westinghouse Co.—"TOURNAPULL"
Mack Trucks, Inc.
Reo Div., The White Motor Co.

TRACTORS, WHEELED
Allis-Chalmers Mfg. Co.
Autocar Div., The White Motor Co.
J. I. Case Co.—"CASE"
Caterpillar Tractor Co.
Diesel Energy Corp.
FWD Corp. "BLUE OX"
The Frank G. Hough Co.
International Harvester Co., Construction Equipment Div.
LeTourneau-Westinghouse Co.—"TOURNATRACTOR TWIN C"
The Oliver Corp.—"OLIVER"

TRAILER AXLES
Clark Equip. Co., Automotive Div.—"CLARK"
Winter-Weiss Co.

TRAILER BODIES
Baughman Mfg. Co., Inc.
Perfection Steel Body Co.
Winter-Weiss Co.

TRAILERS, FULL, BOTTOM-DUMP
The Heil Co., TEC Div.—"TEC"

TRAILERS, FULL, SIDE-DUMP
The Heil Co., TEC Div.—"TEC"

TRAILERS, FULL, REAR-DUMP
The Heil Co., TEC Div.—"TEC"

TRAILERS, BOTTOM-DUMP
Athey Products Corp.
General Motors Corp., Euclid Division
Perfection Steel Body Co.
Sanford Day Iron Works, Inc.

TRAILERS, SIDE-DUMP
Athey Products Corp.
Perfection Steel Body Co.
Truck Engineering Corp.

TRAILERS, REAR-DUMP
Athey Products Corp.
Hercules Steel Products Co.
Perfection Steel Body Co.
Truck Engineering Corp.

TRAILERS, SEMI, BOTTOM-DUMP
Hockensmith Corp.
The Heil Co., TEC Div.—"TEC"
KW-Dart Truck Co.
LeTourneau-Westinghouse Co.—"TOURNAPULL"
Marion Metal Products Co.
Perfection Steel Body Co.

TRAILERS, SEMI, SIDE-DUMP
The Heil Co., TEC Div.—"TEC"
Hockensmith Corp.
LeTourneau-Westinghouse Co.—"TOURNAPULL"
Marion Metal Products Co.
Perfection Steel Body Co.

TRAILERS, SEMI, REAR-DUMP
The Heil Co., TEC Div.—"TEC," "HY-TEC," "HY-SPILL"
Hercules Steel Products Co.
Hockensmith Corp.
LeTourneau-Westinghouse Co.—"TOURNAPULL"
Marion Metal Products Co.
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TRANSFER CASES
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Timken Detroit Axle a Div., Rockwell Spring & Axle Co.
Transmission & Axle Div., Rockwell-Standard Corp.

TRANSFORMER STATIONS, PORTABLE
Ensign Electric & Mfg. Co.

TRANSFORMERS, CONTROL, INSTRUMENT
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Link-Belt Co., Dept. CAMGL-59

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The Elreco Corp.—"ELRECO"
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TROLLEY FROGS, ELECTRIC
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Disston Div., H. K. Porter Co., Inc.

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FWD Corp.

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Ford Div. of Ford Motor Co.
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Gar Wood Industries, Inc.
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Marion Metal Products Co.
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Clark Equip. Co., Automotive Div.—"CLARK"
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Warn Mfg. Co.—"LOCK-O-MATIC"

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FWD Corp.
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International Harvester Co., Motor Truck Div.—"INTERNATIONAL"
Koehring Div. of Koehring Co.
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Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY-LAUGHLIN"
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Kersey Mfg. Co., Inc.

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The Fairbanks Co.
Homestead Valve Mfg. Co.
Jenkins Bros.
Midland Pipe & Supply Co.
Walworth Co.
J. A. Zurn Mfg. Div., Zurn Industries, Inc.—"ZURN"

VALVES, AUTOMATIC, FULL FLOW, QUICK OPENING AND SHUTOFF

Coppus Engineering Corp.—"SENTRY"

VALVES, BUTTERFLY

Allis-Chalmers Mfg. Co.
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VALVES, CHECK

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Farris Flexible Valve Corp.—"FLEX VALVE," "SUPER SEAL"
Goyne Pump Co.
Jenkins Bros.
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Ludlow Valve Mfg. Co., Inc.—"LUDLOW," "RENSSELAER"
The Lunkenheimer Co.—"FERRENEWO," "N-M-D," "RENEWO"
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Ohio Brass Co.
R-P & C Valve Div., American Chain & Cable Co., Inc.
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Walworth Co.
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Hunt Valve Co.—"QUICK-AS-WINK"
Jenkins Bros.
Hose Accessories Co.
Pennsylvania Pump & Compressor Co.—"AIRCHECK," "GASCHECK"
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Walworth Co.

VALVES, COMPRESSED AIR UNLOADING

R. Conrader Co., Inc.—"CONRADER"

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Homestead Valve Mfg. Co.
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VALVES, DIAPHRAGM

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Foxboro Co.
Grinnell Co.—"GRINNELL-SAUNDERS"
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Fischer & Porter Co.
J. A. Zurn Mfg. Div., Zurn Industries, Inc.—"ZURN"

VALVES, FOOT

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Flood City Brass & Electric Co.
Ledeen Mfg. Co.
Ludlow Valve Mfg. Co., Inc.—"LUDLOW"
Midland Pipe & Supply Co.
Walworth Co.

VALVES, 4-WAY & 3-WAY

Ledeen, Inc.

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Crane Co.
Electric Steel Foundry Co.
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Fischer & Porter Co.
Guyan Machy. Co.
Jenkins Bros.
Kennedy Valve Mfg. Co.
Link-Belt Co., Dept. CAMGL-59
Ludlow Valve Mfg. Co., Inc.—"LUDLOW," "RENSSELAER"
The Lunkenheimer Co.—"BREECH-LOCK," "CAUSUL," "KING-CLIP"
McNally-Pittsburg Mfg. Corp.
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Ohio Brass Co.
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Walworth Co.
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Guyan Machy. Co.
Jenkins Bros.
Kennedy Valve Mfg. Co.
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Midland Pipe & Supply Co.
Ohio Brass Co.
R-P & C Valve Div., American Chain & Cable Co., Inc.
Walworth Co.
D. T. Williams Valves Detroit Controls Div., American Radiator & Standard Sanitary Corp.
J. A. Zurn Mfg. Div., Zurn Industries, Inc.—"ZURN"

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Galigher Co.—"GALIGHER SQUEEZE"

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Ledeen Mfg. Co.

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Anchor Packing Co.
Electric Steel Foundry Co.

VALVES, SAFETY

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LOWEST FIRST COST ● FEWER PARTS TO MAINTAIN ● COSTS LESS TO MAINTAIN ●

PUMP MORE HOURS ● LESS HEAD ROOM ● LESS FLOOR SPACE ●

Simplicity—The Gorman-Rupp pump is of the self-priming centrifugal type . . . no valves for foreign matter to lodge under and put pump out of service . . . no piston or cylinder liner to be cut out by fine coal . . . no gears, cams or levers to wear or break and otherwise cause trouble. Many operators replace piston type with Gorman-Rupp pumps because of few parts and low maintenance.

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Cleveland Vibrator Co.
Martin Engineering Co.—"VIBROLATOR"
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Syntron Co.—"PULSATING MAGNET"
W. S. Tyler Co.
Viber Co.—"AIRO VIBER," "VIBERLEC," "MODEL PX"

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Kanawha Mfg. Co.

WASHERS, COAL
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Ore Reclamation Co.—"O.R.C."

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Fuel Process Co.—"M-TYPE"
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Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-59—"FLOAT-SINK"
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Ore Reclamation Co.
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.
Wilmot Engineering Co.

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Link-Belt Co., Dept. CAMGL-59
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McNally-Pittsburg Mfg. Corp.

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Fairmont Machinery Co.
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WASHERS, SCREW
Eagle Iron Works
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McLanahan & Stone Corp.

WASHERS, UPWARD-CURRENT
Eagle Iron Works
Fuel Process Co.—"BELKNAP"
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American Minechem Co.
American Well Works

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Dorr-Oliver, Incorporated
Kanawha Mfg. Co.
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K. Prins & Associates
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc.

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Dow Corning Corp.
E. I. du Pont de Nemours & Co., Inc.
Stonhard Co.—"STONSEAL"
Sika Chemical Corp.—"SIKA-FEL"

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Allis-Chalmers Mfg. Co.

WATER SYSTEMS, DOMESTIC
Barnes Mfg. Co.

WATER-TREATMENT EQUIPMENT
Allis-Chalmers Mfg. Co.
B-I-F Industries, Inc.
Shirley Machine Co.

WATTMETERS, CLAMP-ON
Martindale Electric Co.

WEARING PLATES
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WEDGE BARS, TOOTH REPOINTING
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Stulz-Sickles Co.—"MANGANAL"

WEDGE BARS, TOOTH REPOINTING, MANGANESE
Kensington Steel, Div. of Poor & Co.

WEDGES, CONE
The Leetonia Tool Co.

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Air Reduction Sales Co., A Div. of Air Reduction Co., Inc.
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Flood City Brass & Electric Co.
Harnischfeger Corp.
Hobart Bros. Co.
The Lincoln Electric Co.—"SHIELD-ARC," "IDEAL-ARC," "LINCOLNWELD," "LINCWELDER," "INNER-SHIELD," "SQUIRT WELDER
Marathon Coal Bit Co., Inc.—"AIRCO"
Metal & Thermit Corp.—"M & T"
Mosebach Electric & Supply Co.
Penn Machine Co.
Westinghouse Electric Corp.

WELDERS, RAIL BONDING
Erico Products, Inc. —"CADWELD"
Flood City Brass & Electric Co.
Guyan Machy. Co.—"GUYAN"
Ohio Brass Co.
Penn Machine Co.
The Post Glover Electric Co.—"P-G"

WELDERS, RECTIFIER
Harnischfeger Corp.

WELDERS, SEMI-AUTOMATIC
Alloy Rods Co.—"WEAR-O-MATIC WIRE FEED"

WELDERS, TRANSFORMER
Harnischfeger Corp.

WELDING CABLE
Collyer Insulated Wire Co.
Cornish Wire Co., Inc.
Gar Wood Industries, Inc.
General Cable Corp.
General Electric Co., Wire and Cable Dept., Conduit Products Dept.
Guyan Machy. Co.
Hobart Bros. Co.
Kaiser Aluminum & Chemical Sales, Inc.
The Lincoln Electric Co.—"STABLE-ARC," "LINCOLN-DUCTOR"
Marathon Coal Bit Co., Inc.—"AIRCO"
National Electric Products Co.
John A. Roebling's Sons Corp., Sub. Colorado Fuel & Iron Corp.
Rome Cable Corp.—"ROME 60"
Tweco Products, Inc.—"TWECO LITE"

WELDING CARBON PRODUCTS
Helwig Carbon Products, Inc.
Marathon Coal Bit Co., Inc.—"AIRCO"
National Carbon Co., Div. of Union Carbide Corp.
Ohio Carbon Co.
Stackpole Carbon Co.

WELDING, CUTTING TORCHES, OUTFITS
Air Reduction Sales Co., A Div. of Air Reduction Co., Inc.
General Scientific Equipment Co.—"GS"
Marathon Coal Bit Co., Inc.—"AIRCO"

WELDING-ELECTRODE HOLDERS
Air Reduction Sales Co. A Div. of Air Reduction Co., Inc.
Erico Products, Inc.—"CADDY"
Guyan Machy. Co.
Hobart Bros. Co.
The Lincoln Electric Co.—"COOLTONG," "INS," "HT," "T"
Mosebach Electric & Supply Co.
Tweco Products, Inc.—"TWECOTONG"

WELDING ELECTRODES AND GAS WELDING WIRE
Page Steel & Wire Div., American Chain & Cable Co., Inc.

WELDING ELECTRODES
Alloy Rods Co.—"ATOM ARC," "ARCALOY," "TOOL ARC," "NICKEL ARC," "BRONZE ARC"
Ampco Metal, Inc.—"AMPCO TRODE," "PHOS-TRODE," "AMPCO-WELD" "AMPCO-BRAZ"
Crucible Steel Co. of America
Electric Welding Alloys Corp. "BRONZOCHROM" "CASTOLIN EUTECTIC," "CUTRODE," "EUTECTROM," "EUTECTIC LOW TEMPERATURE WELDING ALLOYS," "FRIGID ARC," "HANDMATIC," "SEELTECTIC," "EUTECTRODE," "STAINTRODE," "CHAMFERRODE," "LOW AMP," "UNIMATIC," "XYRON," "NITECTIC," "TOOLTECTIC"
Flood City Brass & Electric Co.
Guyan Machy. Co.—"MUREX"
Harnischfeger Corp.
Hobart Bros. Co.
The Lincoln Electric Co.—"JET-WELD," "FLEETWELD," "SHIELD-ARC," "STAIN-WELD," "ALUMINUM-WELD," "AERISWELD," "FERRO WELD," "PLANE-WELD," SOFTWELD"
Lukens Steel Co.—"LUKENS PLATEMATE"
Marathon Coal Bit Co., Inc.—"AIRCO"
Metal & Thermit Corp.—"MUREX"
Stulz-Sickles Co.—"MANGANAL"
Taylor-Wharton Co. Div., Harsco Corp.—"TIMANG"
Wall Colmonoy Corp.—"HARD-FACING"
Westinghouse Electric Corp.

WELDING ELECTRODES, CARBON
Crucible Steel Co. of America—"STAINLESS"
Helwig Carbon Products, Inc.
Hobart Bros. Co.
The Lincoln Electric Co.—"E 321" "E832
Marathon Coal Bit Co. Inc.—"AIRCO"
National Carbon Co., Div. of Union Carbide Corp.
Ohio Carbon Co.
Pure Carbon Co., Inc.
Stackpole Carbon Co.

WELDING ELECTRODES, GRAPHITE
Helwig Carbon Products, Inc.
Hobart Bros. Co.
Marathon Coal Bit Co. Inc.—"AIRCO"
National Carbon Co., Div. of Union Carbide Corp.
Ohio Carbon Co.
Stackpole Carbon Co.

WELDING ELECTRODES, NICKEL, NICKEL ALLOY
International Nickel Co., Inc.

WELDING EQUIPMENT, INERT GAS ARC
Air Reduction Sales Co., A Div. of Air Reduction Co., Inc.

WELDING-FLUX RECLAIMING SCREENS
Simplicity Engineering Co.

WELDING FLUXES
Eutectic Welding Alloys Corp.—"EUTECTOR FLUXES" "ATMOS FLUX," "AUTO-CHEMIC FLUXES," "EUTECSOL FLUX," "FLOTECTIC FLUXES"
The Lincoln Electric Co.—"LINCOLNWED 760, 780, 781, 840"
Marathon Coal Bit Co. Inc.—"AIRCO"
The Sight Feed Generator Co.—"REXARC"

WELDING GASES
Air Reduction Sales Co., A Div. of Air Reduction Co., Inc.
Guyan Machy. Co.
Marathon Coal Bit Co. Inc.—"AIRCO"

WELDING GOGGLES
Air Reduction Sales Co., A Div. of Air Reduction Co., Inc.
American Optical Co., Safety Products Div.—"NOVI-WELD," "DURAWELD"
Bausch & Lomb Optical Co.
Chicago Eye Shield Co.
Flood City Brass & Electric Co.
General Scientific Equipment Co.—"GS"
Guyan Machy. Co.
Hobart Bros. Co.
Marathon Coal Bit Co. Inc.—"AIRCO"
Mine Safety Appliances Co.
Ore Reclamation Co.
Pulmosan Safety Equip. Co
United States Safety Service Co.

WELDING GROUND CLAMPS
Albert & J. M. Anderson Mfg. Co
Erico Products, Inc.—"CADDY"
Flood City Brass & Electric Co.
Hobart Bros. Co.
The Lincoln Electric Co.—"GC 300," "GC 500"
Marathon Coal Bit Co., Inc.—"AIRCO"
Ohio Brass Co. "KLIPLOK"
Trico Fuse Mfg. Co.
Tweco Products, Inc.—"TWECO"

WELDING HELMETS
American Optical Co., Safety Products Div.—"WELD "COOL"
Chicago Eye Shield Co.
Flood City Brass & Electric Co.
General Scientific Equipment Co.—"GS"
Guyan Machy. Co.
Hobart Bros. Co.
The Lincoln Electric Co.—"COMFORT SHIELD," "LPH," "FMH"
Marathon Coal Bit Co. Inc.—"AIRCO"
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
Westinghouse Electric Corp.

WELDING HOLDERS
Flood City Brass & Electric Co.
Hobart Bros. Co.
Marathon Coal Bit Co. Inc.—"AIRCO"

WELDING HOSE
Acme-Hamilton Rubber Mfg. Corp.—"STAPLE"
Carlyle Rubber Co., Inc.
Goodyear Tire & Rubber Co.
Guyan Machy. Co.
Hewitt-Robins Incorporated—"TWIN-WELD"
Marathon Coal Bit Co. Inc.—"AIRCO"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Thermoid Co.

WELDING PLUGS
Tweco Products, Inc.

WELDING PLUGS, ELECTRICAL
Joy Mfg. Co.

WELDING POSITIONERS
Harnischfeger Corp.
The Sight Feed Generator Co.—"REXARC"

WELDING RECTIFIERS
Hobart Bros. Co.
Marathon Coal Bit Co. Inc.—"AIRCO"

WELDING ROD, WIRE
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"

WELDING SHIELDS
American Optical Co., Safety Products Div.
Flood City Brass & Electric Co.
General Scientific Equipment Co.—"GS"
Hobart Bros. Co.
Marathon Coal Bit Co., Inc.—"AIRCO"
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
Westinghouse Electric Corp.

WELDING TRANSFORMERS
Guyan Machy. Co.—"M & T"
Hobart Bros. Co.
The Lincoln Electric Co.—"IDEALARC," "LINC-WELDER"
Marathon Coal Bit Co. Inc.—"AIRCO"
Westinghouse Electric Co.

WELDING-TUBE FITTINGS
Parker Fittings & Hose Div., Parker-Hannifin Corp.—"WELD-LOK"

WELDING WIRE
Lukens-Steel Co.—"LUKENS PLATE MATE"
Drawalloy Corp.—"DRAW-ALLOY"

WELDING WIRE, AUTOMATIC
The Sight Feed Generator Co.—"REXARC"

WELDMENTS
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
American Car & Foundry Div., ACF Industries, Inc.
Bethlehem Steel Co.
Connellsville Mfg. & Mine Supply Co.
The Falk Corp.
Farrel-Birmingham Co., Inc.
Koven Fabricators, Inc.
Meckum Engineering, Inc.
Phoenix Steel Corp., Structural & Tube Divs.
Sanford Day Iron Works, Inc.

WELDMENTS, CAST
Electric Steel Foundry Co.

WETTING AGENTS
American Minechem Co.

WHEELBARROWS
The Wood Shovel & Tool Co.

WHEELBARROWS, POWERED
Prime Mover Co.—"15B"

WHEELS, LOCOMOTIVE, CAST-IRON
American Car & Foundry Div., ACF Industries, Inc.
Ironton Engine Co.—"IRONTON"
Irwin Sensenich Corp.

WHEELS, LOCOMOTIVE, STEEL
Bethlehem Steel Co.
Farrell-Cheek Steel Co.
Ironton Engine Co.—"IRONTON"
Pittsburgh Gear Co.
Sterling Steel Casting Co.

WHEELS, LOCOMOTIVE, STEEL REBUILT
Leman Machine Co.

WHEELS, MACHINE-TRUCK
Enterprise Wheel & Car Corp.
Irwin Sensenich Corp.
United States Rubber Co.

WHEELS, MINE-CAR
Farrell-Cheek Steel Co.
Link-Belt Co., Dept. CAMGL-59

WHEELS, MINE-CAR, CAST-IRON
American Car & Foundry Div., ACF Industries, Inc.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Gibralter Equipment & Mfg. Co. —"GEMCO TRU-BLU"
Helmick Foundry-Machine Co.
Hockensmith Corp.
Irwin-Sensenich Corp.
Kanawha Mfg. Co.
McLanahan & Stone Corp.
Sanford Day Iron Works, Inc.
Watt Car & Wheel Co.

WHEELS, MINE-CAR, MANGANESE
Kensington Steel, Div. of Poor & Co.

WHEELS, MINE-CAR, STEEL
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Bethlehem Steel Co.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Farrell-Cheek Steel Co.
Gibralter Equipment & Mfg. Co. —"GEMCO TRU-BLU"
Irwin-Sensenich Corp.
National Malleable & Steel Castings Co.—"NACO"
Sanford Day Iron Works, Inc.
Sterling Steel Casting Co.
Watt Car & Wheel Co.

WINCHES
Chicago Pneumatic Tool Co.
J. D. Christian Engineers
Clyde Iron Works, Inc.
Cowanesque Valley Iron Works
Gar Wood Industries, Inc.
Hewitt-Robins Incorporated
Ledeen Mfg. Co.
Link-Belt Co., Dept. CAMGL-59
Sauerman Bros., Inc.
Shepard Niles Crane & Hoist Corp.
Stephens-Adamson Mfg. Co.
Vickers, Inc., Tulsa Winch Div. —"TULSA"

WINCHES, AIR
Joy Mfg. Co.

WINCHES, PIPE DRIVING
Sprague & Henwood, Inc.

WIRE
Republic Steel—"REPUBLIC"

WIRE, ARMATURE BANDING, STAINLESS, CARBON STEEL
Page Steel & Wire Div., American Chain & Cable Co., Inc.

WIRE, ELECTRICAL—See Also Cable

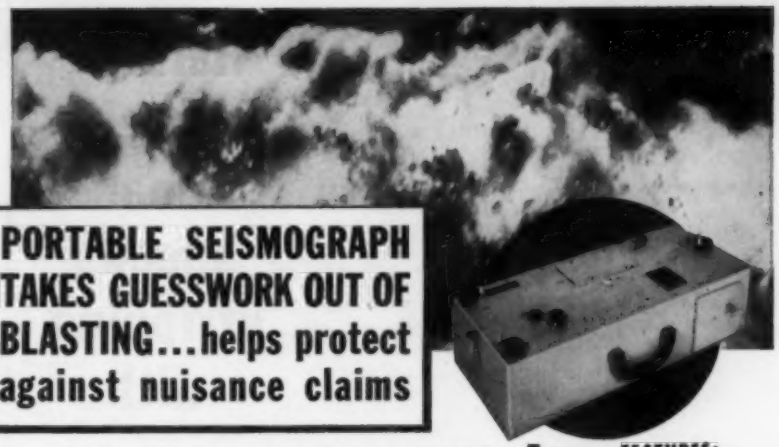
WIRE, ELECTRICAL, BARE
American Steel & Wire Div., U. S. Steel Corp.—"TIGER BRAND"
Circle Wire & Cable Corp.
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
John Flocker & Co.
General Cable Corp.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Corp., Sub., Colorado Fuel & Iron Corp.
Rome Cable Corp.

WIRE, ELECTRICAL, INSULATED
American Steel & Wire Div., U. S. Steel Corp.
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
Copperweld Steel Co., Wire & Cable Div.—"COPPER-WELD" "ALUMOWELD"
Cornish Wire Co., Inc.
Ensign Electric & Mfg. Co.
John Flocker & Co.
General Cable Corp.
General Electric Co., Wire and Cable Dept., Conduit Products Dept.
Joy Mfg. Co.
Kaiser Aluminum & Chemical Sales Inc.
National Electric Products Co.
National Mine Service Co.
Okonite Co.
Phelps Dodge Copper Products Co.
Rockbestos Products Corp., Sub. of Cerro de Pasco Corp.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
Rome Cable Corp.
Simplex Wire & Cable Co.

WIRE, FEEDER
Aluminum Company of America
American Steel & Wire Div., U. S. Steel Corp.
Anaconda Wire & Cable Co.
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
John Flocker & Co.
General Cable Corp.
General Electric Co., Wire & Cable Dept., Conduit Products Dept.
Joy Mfg. Co.
Kaiser Aluminum & Chemical Sales, Inc.
Mosebach Electric & Supply Co.
Phelps Dodge Copper Products Co.
Rome Cable Corp.

WIRE, SHAPED
Page Steel & Wire Div., American Chain & Cable Co., Inc.

WIRE, SHOTFIRING
American Steel & Wire Div., U. S. Steel Corp.
Circle Wire & Cable Corp.



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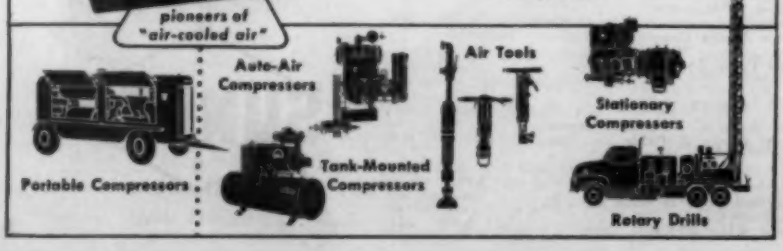

Cornish Wire Co., Inc.
John Flocker & Co.
General Cable Corp.
General Electric Co., Wire and Cable Dept., Conduit Products Dept.
Kaiser Aluminum & Chemical Sales, Inc.
National Mine Service Co.
Okonite Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.
Phelps Dodge Copper Products Co.
Rome Cable Corp.

WIRE, TELEPHONE

American Steel & Wire Div., U. S. Steel Corp.—"AMERTEL"
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
John Flocker & Co.
General Cable Corp.
Kaiser Aluminum & Chemical Sales, Inc. —"ACCOALUMINIZED"
National Electric Products Co.
Okonite Co.
Page Steel & Wire Div., American Chain & Cable Co., Inc.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Corp. Sub. Colorado Fuel & Iron Corp.

WIRE, THERMOCOUPLE

West Instrument Corp.

WIRE, TROLLEY

Aluminum Co. of America
American Steel & Wire Div., U. S. Steel Corp.
Anaconda Wire & Cable Co.
John Flocker & Co.
General Cable Corp.
Mosebach Electric & Supply Co.
National Mine Service Co.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.

WIRE CLOTH

Hewitt-Robins Incorporated—"GYRALOY," "SUPER "GYRALOY"
Hoyt Wire Cloth Co.—"SUPERTOUGH," "ABRASO," "SUPERHARD STAINLESS STEEL," "SMOOTH TOP," "LONG-SLOT," "OBLONG DOUBLE CRIMP"
Ludlow Saylor Wire Cloth Co.
W. S. Tyler Co.

WIRE ENAMELS

General Electric Co., Chemical & Metallurgical Div., Insulating Materials Dept.

WIRE ROPE

American Chain & Cable—"LAY-SET," "TRU-LAY," "VHS"
American Steel & Wire Div., U. S. Steel Corp.—"TIGER BRAND"
Bergen Wire Rope Co.
Bethlehem Steel Co.
The Bowdil Co.
Broderick & Bascom Rope Co. —"YELLOW STRAND" "POWERSTEEL"
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div. —"WICKWIRE"
John Flocker & Co.
Flood City Brass & Electric Co.
Guyan Machy. Co.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div., H. K. Porter Co., Inc.—"HERCULES RED STRAND," "PORTER IMPERIAL RED STRAND"
LeTourneau-Westinghouse Co. —"TOUNAROPE"
Macwhyte Wire Rope Co.— —"WHYTE STRAND," "MACWHYTE"
Marathon Coal Bit Co. Inc.— "BETHLEHEM," "MACWHYTE"
Mosebach Electric & Supply Co.
National Mine Service Co.
Kurt Orban Co., Inc., Industrial Equipment Div.

Ore Reclamation Co.
Rochester Ropes, Inc.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
Joseph T. Ryerson & Son, Inc.
Sauerman Bros., Inc.
W. J. Savage Co.
Union Wire Rope Corp. Sub of Armco Steel Corp.—"TUFFY"
The Upson-Walton Co.
West Virginia Armature Co.
Wire Rope Corp. of America, Inc.—"WIRECO" "BROWN STRAND"

WIRE-ROPE, CONDUCTOR-CORE

American Chain & Cable—"SIGNALKORE"

WIRE ROPE, PLASTIC COATED

Rochester Ropes, Inc.

WIRE, ROPE, STAINLESS, MONEL, PLASTIC COATED AND NYLON COATED

Macwhyte Wire Rope Co.

WIRE ROPE, SWING TAIL, CAR-PULLER

The Upson-Walton Co.

WIRE ROPE BOOM PENDANTS

Union Wire Rope Corp., Sub. of Armco Steel Corp.

WIRE-ROPE CLAMPS

Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
John Flocker & Co.
Jones & Laughlin Steel Corp.—"JALKLAMPS"
Marathon Coal Bit Co. Inc.—"BETHLEHEM"
Mosebach Electric & Supply Co.
Ore Reclamation Co.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
Joseph T. Ryerson & Son, Inc.
Sauerman Bros., Inc.
Union Wire Rope Corp., Div. of Armco Steel Corp.
The Upson-Walton Co.

WIRE-ROPE CLIPS

American Chain & Cable—"ACCO CLIPS"
American Logging Tool Corp., Sub. of Broderick & Bascom Rope Co.—"ALTCO"
Broderick & Bascom Rope Co.—"YELLOW STRAND"
Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY"
Ensign Electric & Mfg. Co.
Farrell-Cheek Steel Co.
John Flocker & Co.
Guyan Machy. Co.
Jones & Laughlin Steel Corp.
Macwhyte Wire Rope Co.
Marathon Coal Bit Co., Inc.—"BETHLEHEM"
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
Joseph T. Ryerson & Son, Inc.
W. J. Savage Co.
Union Wire Rope Corp., Div. of Armco Steel Corp.
The Upson-Walton Co.—"GOLD CLIP"
Wire Rope Corp. of America, Inc.—"WIRECO"

WIRE-ROPE DRESSING, LUBRICANTS

Ashland Oil & Refining Co.—"VALVOLINE-ASHLAND"
Cities Service Oil Co.
Esso Standard Oil Co.—"SURETT," "SURRETT FLUIDS," "COBLAX"
John Flocker & Co.
Hulburt Oil & Grease Co.
Leschen Wire Rope Div., H. K. Porter Co., Inc.—"LEPRO"
Macwhyte Wire Rope Co.
New York & New Jersey Lubricant Co.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
Shell Oil Co.
Socony Mobil Oil Co. Inc.
Sun Oil Co.—"AEROSOL"
Swan-Finch Petro Chemicals
Texaco, Inc.
The Whitmore Mfg. Co.—"WHITMORE'S PRESSUREPROOF"

WIRE-ROPE EYES

American Chain & Cable
John Flocker & Co.
Jones & Laughlin Steel Corp.
Joy Mfg. Co.
Macwhyte Wire Rope Co.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.

WIRE-ROPE FITTINGS

American Steel & Wire Div., U. S. Steel Corp.
Farrell-Cheek Steel Co.
Rochester Ropes, Inc.
Wire Rope Corp. of America, Inc.—"WIRECO"

WIRE-ROPE SHACKLES

American Chain & Cable
Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Electric Steel Foundry Co.
Farrell-Cheek Steel Co.
John Flocker & Co.
Jones & Laughlin Steel Corp.
Macwhyte Wire Rope Co.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
Union Wire Rope Corp., Div. of Armco Steel Corp.
The Upson-Walton Co.

WIRE-ROPE SLINGS

Guyan Machinery Co.
Rochester Ropes, Inc.

WIRE-ROPE SOCKETS

American Chain & Cable
The Bowdil Co.
Crosby-Laughlin Div., American Hoist & Derrick Co. —"CROSBY," "LAUGHLIN"
Electric Steel Foundry Co.
Farrell-Cheek Steel Co.
John Flocker & Co.
Jones & Laughlin Steel Corp.
Macwhyte Wire Rope Co.
Mosebach Electric & Supply Co.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
Sauerman Bros., Inc.
Union Wire Rope Corp. Div. of Armco Steel Corp.
The Upson-Walton Co.

WIRE-ROPE SWAGED ASSEMBLIES

American Chain & Cable—"TRU-LOC"
Bethlehem Steel Co.
Broderick & Bascom Rope Co.—"BROLOC"
Electric Steel Foundry Co.
John Flocker & Co.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div., H. K. Porter Co., Inc.
Macwhyte Wire Rope Co.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
W. J. Savage Co.
Union Wire Rope Corp., Div. of Armco Steel Corp.
Wire Rope Corp. of America, Inc. —"WIRECO"

WIRE-ROPE SWIVELS

Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
John Flocker & Co.
Jones & Laughlin Steel Corp.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
The Upson-Walton Co.

WIRE-ROPE THIMBLES

Crosby-Laughlin Div. American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Farrell-Cheek Steel Co.
John Flocker & Co.
Guyan Machy. Co.
Jones & Laughlin Steel Corp.
Macwhyte Wire Rope Co. s
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
The Upson-Walton Co.
Union Wire Rope Corp., Div. of Armco Steel Corp.

WIRE STRIPPERS

Martindale Electric Co.

WIRING DEVICES

The Elreco Corp.
Holub Industries, Inc.
National Electric Products Co.
United States Rubber Co.

WOOD PRESERVATIVES

Darworth, Inc., Chemical Products Div.—"CUPRINOL"
The Dow Chemical Co.
T. J. Moss Tie Co.
Osmose Wood Preserving Co.—"OSMOSALTS," "OSMOPLASTIC," "M-T-M"
The Wilbur & Williams Co. Inc. —"PERMODIP"

WRENCHES, BIT

Duquesne Mine Supply Co.
Guyan Machy. Co.
Joy Mfg. Co.
The Leetonia Tool Co.
Marathon Coal Bit Co. Inc.—"MARATHON," "PROTO"
Frank Prox Company Inc.
Bertrand P. Tracy Co.

WRENCHES, HOPPER

Advance Car Mover Co., Inc.—"ADVANCE SAFETY"

WRENCHES, IMPACT

Black & Decker Mfg. Co.
Chicago Pneumatic Tool Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Marathon Coal Bit Co. Inc.—"PROTO"
Penn Machine Co.
Remington Arms Co., Inc.
Schroeder Brothers Corp.
Snap-on Tools Corp.
Thor Power Tool Co.

WRENCHES, SET SCREW

The Leetonia Tool Co.

WRENCHES, TORQUE

Bearings, Inc.
Ingersoll-Rand Co.
Marathon Coal Bit Co. Inc.—"PROTO"
Schroeder Brothers Corp.
Snap-on Tools orp.

WRENCHES, TRACK

Gibraltar Equipment & Mfg. Co.
Guyan Machy. Co.
Ingersoll-Rand Co.
Nordberg Mfg. Co.

YO-YOS, ELECTRIC

The Nolan Co.

YO-YOS, HYDRAULIC

The Nolan Co.
Schroeder Brothers Corp.
W. R. Stamler Corp.

YO-YOS, HYDRAULIC, REBUILT

Leman Machine Co.

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The Coal Age Mining Guidebook . . .

Directory of Manufacturers

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A

ABC Scale Div., McDowell Co., Inc., 113 St. Clair Ave. N.E., Cleveland 14, Ohio
Charles Abbott and Associates, 29 W. 74th St., New York 23, N. Y.
Acker Drill Co., Inc., P. O. Box 830, Scranton, Pa.
Acme Chain Corp., 821 Main St., Holyoke, Mass.
Acme Electric Corp., 2009 Water St., Cuba, N. Y.
Acme-Hamilton Mfg. Corp., Meade St., Trenton, N.J. ADV p39, 347
Acme Machinery Co., Box 616, Huntington, W. Va., ADV. p153
Advance Car Mover Co., Inc., Box 536, Appleton, Wis.
Aerial Surveys, Inc., 4614 Prospect Ave., Cleveland, Ohio
Aero Service Corp., 210 East Courtland St., Philadelphia 20, Pa.
Aeroquip Corp., 300 S. East Ave., Jackson, Mich., ADV. p154
Ahlberg Bearing Co., 3025 West 47 St., Chicago 32, Ill.
Airdox Cardox Products Co., 307 N. Michigan Ave., Chicago 1, Ill., ADV. p65
Air Reduction Sales Co., A Div. of Air Reduction Co., Inc., 150 East 42nd St., New York 17, N. Y.
Airmite-Midwest, Inc., 119 North Chestnut St., DuQuoin, Ill.
Ajax Flexible Coupling Co., Inc., 17 English St., Westfield, N. Y.
The Aldon Co., 3228 Ravenswood Ave., Chicago 13, Ill.
Aldrich Pump Co., 1 Pine St., Allentown, Pa.
Alleghany Ludlum Steel Corp., Carmet Div., 1500 Jarvis Ave., Detroit 20, Mich., ADV. p137
Allen & Garcia Co., 322 South Michigan Ave., Chicago 4, Ill.
Allen-Sherman-Hoff Pump Co., 259 East Lancaster Ave., Wynnewood, Pa., ADV. p155
Allied Chemical Corp., Nitrogen Div., 40 Rector St., New York 6, N. Y.
Allis-Chalmers Mfg. Co., 986 South 70 St., Milwaukee 1, Wis., ADV. p171
The Louis Allis Co., 486 East Stewart St., Milwaukee 1, Wis.
Allison-Campbell Div., American Chain & Cable Co., Inc., 929 Connecticut Ave., Bridgeport 2, Conn.
Allison Div., General Motors Corp., 4700 W. 10th St., Indianapolis, Ind.
Alloy Rods Co., York, Pa., ADV. p413
Alloy Steel Castings Co., 205 County Line Rd., Southampton, Pa.
Aluminum Company of America, 1501 Alcoa Bldg., Pittsburgh 19, Pa., ADV. pp347, 348-349, 350
Amercoat Corp., 4809 Firestone Blvd., South Gate, Calif.
American Air Filter Co., Inc., 267 Central Ave., Louisville 8, Ky.
American Air Surveys, Inc., 907 Penn Ave., Pittsburgh 22, Pa.
American Alloy Corp., 3885 E. 78th St., Cleveland 5, Ohio
American Brake Shoe Co., American Brakeblok Div., P. O. Box 21, Birmingham, Mich.
American Brake Shoe Co., National Bearing Div., 717 Grant Bldg., Pittsburgh 19, Pa.
American Brake Shoe Co., Railroad Products Div., 530 Fifth Ave., New York 36, N. Y.
American Brattice Cloth Corp., 200 Argonne Rd., Warsaw, Ind., ADV. p420
American Bridge Div., U. S. Steel Corp., 204 Frick Bldg., Pittsburgh 30, Pa.
American Car & Foundry Div., ACF Industries, Inc., 730 Third Ave., New York 17, N. Y., ADV. Second Cover, p390
American Chain & Cable, Wilkes Barre, Pa.
American Chain Div., American Chain & Cable Co., Inc., E. Princess & Charles Sts., York, Pa.
American Conveyor Co., 2133-37 South Christiana, Chicago 23, Ill.
American Crucible Products Co., Oberlin Rd., Lorain, Ohio
American Crucible Products Co., Kenco Pump Div., Oberlin Rd., Lorain, Ohio
American Cyanamid Co., Explosives and Mining Chemicals Dept., 30 Rockefeller Plaza, New York 20, N. Y., ADV. p53, 383
American Engineering Co., Wheatsheaf Lane & Sepviva St., Philadelphia 37, Pa.
American Hoist & Derrick Co., 63 South Robert St., St. Paul 7, Minn.
American LaFrance, Div. of Sterling Precision Corp., 100 East LaFrance St., Elmira, N. Y.
American Logging Tool Corp., Sub. of Broderick & Bascom Rope Co., 4202 Union Blvd., St. Louis 15, Mo.
American Manganese Steel Div., American Brake Shoe Co., Chicago Heights, Ill., ADV. p177
American MARC Inc., 1601 West Florence Ave., P. O. Box 549, Inglewood, Calif.
American-Marsh Pumps, Inc., 50 Capitol Ave., N. E., Battle Creek, Mich.
American Mine Door Co., 2857 Dueber Ave., S. W., Canton 6, Ohio, ADV. p365
American Mine Supply Co., 404 Frick Bldg., Pittsburgh 19, Pa.
American Minechem Co., P. O. Box 231, Coraopolis, Pa.
The American Oil Co., 555 Fifth Ave., New York 17, N. Y., ADV. p141
American Optical Co., Safety Products Div., Dept. 4634G, 80 Mechanic St., Southbridge, Mass.
American Paulin System, 1524 South Flower St., Los Angeles 15, Calif.
The American Pulley Co., 4200 Wissahickon Ave., Philadelphia 29, Pa.
American Pulverizer Co., 1249 Macklind Ave., St. Louis 10, Mo., ADV. p399
American-Standard Industrial Div., Detroit 32, Mich.
American Steel Foundries, 3761 Canal St., East Chicago, Ind.
American Steel & Wire Div., United States Steel Corp., Rockefeller Bldg., Cleveland 13, Ohio, ADV. pp48-49, 168-169
American Well Works, 162 North Broadway, Aurora, Ill.
Jack Ammann Photogrammetric Engineers, Inc., 931 Broadway, San Antonio 5, Texas
Ampco Metal, Inc., 1723 South 28 St., Milwaukee, Wis.
Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y., ADV. pp386-387
Analytical Measurements, Inc., 585 Main St., Chatham, N. J.
Anchor Coupling Co., Inc., 342 No. Fourth St., Libertyville, Ill.
Anchor Packing Co., 401 North Broad St., Philadelphia 8, Pa.
Albert & J. M. Anderson Mfg. Co., 289 A St., Boston 10, Mass.
The Ansonia Wire & Cable Co., 111 Martin St., Ashton, R. I.
Ansul Chemical Co., Marinette, Wis.
Armco Drainage & Metal Products, Inc., Middletown, Ohio
Armstrong, Bray & Co., 5364 Northwest Hwy., Chicago 30, Ill.
Arrow Hart & Hegeman Electric Co., 104 Hawthorne St., Hartford 6, Conn.
Arrowhead Engineers and Constructors, Inc., 1192 W. Railroad St., Duluth 2, Minn.
Ashland Oil & Refining Co., Ashland, Ky.
Athey Products Corp., 5631 W. 65 St., Chicago 38, Ill.
Atkinson Armature Works, 116 1st St., Pittsburg, Kan., ADV. p397
Atlas Powder Co., Wilmington 99, Del., ADV. p171
Auburn Foundry, Inc., Heating Div., Auburn, Ind.
Aurora Pump Div., The New York Air Brake Co., 619 Loucks St., Aurora, Ill.
Austin Powder Co., Rockefeller Bldg., Cleveland 13, Ohio
Austin-Western, Construction Equipment Div., Baldwin-Lima-Hamilton Corp., 601 N. Farnsworth Ave., Aurora, Ill., ADV. p149
Autocar Div., The White Motor Co., Exton, Pa., ADV. p131
Automatic Vulcanizers Corp., 16 Hudson St., New York, N. Y. ADV. p421
Axeman-Anderson Co., 223 West St., Williamsport 3, Pa

B

Baldwin-Lima-Hamilton Corp., Construction Equipment Div., South Main St., Lima, Ohio, ADV. p46
Bando Rubber Mfg. Co., 1-2-Chome, Meiwa-Dori, Hyogo-Ku, Kobe, Japan
Bantam Bearings Div., Torrington Co., 3702 West Sample St., South Bend 21, Ind.
Barber-Greene Co., 400 N. Highland Ave., Aurora, Ill., ADV. p43
Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.
Barnes Mfg. Co., 615 N. Main St., Mansfield, Ohio
Barrett, Haentjens & Co., Hazleton, Pa.
Baton & Co., Geo. S., 1100 Union Trust Bldg., Pittsburgh 19, Pa.
Baughman Mfg. Co., Inc., Shipman Rd., Jerseyville, Ill.
Bausch & Lomb Optical Co., 80459 St. Paul St., Rochester 2, N. Y.
Bearing Service Co., 4650-52 Baum Blvd., Pittsburgh 13, Pa.
Bearings, Inc., 3634 Euclid Ave., Cleveland, Ohio
Bemis Bro. Bag Co., 408-9 Pine St., St. Louis 2, Mo.
Bergen Wire Rope Co., 151 Gregg St., Lodi, N. J.
C. L. Berger & Sons, Inc., 37 Williams St., Roxbury 19, Mass.
Bete Fog Nozzle, Inc., 309 Wells St., Greenfield, Mass.
Bethlehem Steel Co., 701 East Third St., Bethlehem, Pa., ADV. pp45, 97, 129
B-I-F Industries, Inc., 345 Harris Ave., Providence, R. I.
Bigelow-Liptak Corp., 13300 Puritan Ave., Detroit 27, Mich.
Bin-Dicator Co., 13946 Kercheval St., Detroit 15, Mich.
Bird Machine Co., South Walpole, Mass., ADV. p4
Bituminous Casualty Corp., Bituminous Bldg., 320 18th St., Rock Island, Ill.
Bixby-Zimmer Engineering Co., 961 Abington St., Galesburg, Ill., ADV. P361
Black & Decker Mfg. Co., 600 E. Pennsylvania Ave., Towson, Md.
Black Diamond Spad Co., 2108 Stratford Rd., Richmond 25, Va.

Blackhawk Mfg. Co., 5325 W. Rogers St., Milwaukee 46, Wis.
Blaw-Knox Co., Blaw-Knox Equipment Div., Pittsburgh 38, Pa.
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co., P. O. Box 1071, Boston 3, Mass., ADV. p19
The Bowdil Co., Boylan Ave., S. E., Canton, Ohio, ADV. p52
The Branford Co., 132 Glen St., New Britain, Conn.
The Bristol Co., P. O. Box 1790 CA, Waterbury 20, Conn.
Broderick & Bascom Rope Co., 4203 Union Blvd., St. Louis 15, Mo., ADV. p6
The Brooks Oil Co., 3304 East 87th St., Cleveland 27, Ohio
Brookville Locomotive Works, Steele Blvd., Brookville, Pa.
Browning Mfg. Co., Maysville, Ky.
Charles Bruning Co., Inc., Mount Prospect, Ill.
Brunner & Lay, Inc., 9300 King St., Franklin Park, Ill.
Brunner & Lay Eastern, Inc., 2514-16 E. Cumberland St., Philadelphia 25, Pa.
Bucyrus-Erie Co., South Milwaukee, Wis., ADV. pp125, 425
Buffalo Forge Co., 490 Broadway, Buffalo 5, N. Y.
Buffalo Scale Co., Inc., 46 Letchworth St., Buffalo 13, N. Y.
E. D. Bullard Co., 2680 Bridgeway, Sausalito, Calif.
Burndy Corp., Richards Ave., Norwalk, Conn.
Bussmann Mfg. Div., McGraw-Edison Co., University at Jefferson, St. Louis 7, Mo.
Buttner Works, Inc., 52 Vanderbilt Ave., New York 17, N. Y. ADV. p389
A. M. Byers Co., Clark Bldg., Pittsburgh 22, Pa.
Byron Jackson Pumps, Inc., A Sub. of Borg-Warner Corp., 2301 East Vernon, Los Angeles, Calif.

C

C & D Batteries, Inc., Conshohocken, Pa.
Cable Vulcanizing Shop, Inc., Box 66, Pecks Mill, W. Va.
Samuel Cabot, Inc., 141 Milk St., Boston 9, Mass.
Cambridge Wire Cloth, Cambridge, Md.
E. K. Campbell Co., 1809 Manchester Ave., Kansas City 26, Mo.
Canton Stoker Corp., 741 Andrew Place, S. W., Canton, Ohio
C. S. Card Iron Works, P. O. Box 117, Denver 1, Colo.
Philip Carey Mfg. Co., Lockland, Cincinnati 15, Ohio
Carlon Products Corp., 10225 Meech Ave., Cleveland 5, Ohio
Carlyle Rubber Co., Inc., 103-107 Warren St., New York 7, N. Y.
Carolina Tire Co., 232 N. Main St., Salisbury, N. C.
Carpenter Heating & Air Conditioning Co., 2135 St. Clair Ave., Cleveland, Ohio.
Carrier Conveyor Corp., 211 N. Jackson St., Louisville 2, Ky., ADV. p414
Carver Pump Co., Muscatine, Iowa
J. I. Case Co., 700 State St., Racine, Wis.
A. W. Cash Co., P. O. Box 551, Decatur, Ill.
A. W. Cash Valve Mfg. Corp., 655 E. Wabash, Decatur, Ill.
Caterpillar Tractor Co., Peoria, Ill., ADV. p29
Cement Gun Co., 1520 Walnut St., Allentown, Pa.
Central Mine Equipment Co., 6200 N. Broadway, St. Louis 15, Mo.
Central Mine Supply Co., Div. Pickard Industries, Inc., Mt. Vernon, Ill.
Central Scientific Co., 1700 Irving Park Blvd., Chicago 13, Ill.
Centrifugal & Mech. Industries, Inc., 146 President St., St. Louis 18, Mo., ADV. p135
Chain Belt Co., 4786 W. Greenfield Ave., Milwaukee 1, Wis.
Chain Belt Co., Shafer Bearing Div., P. O. Box 57, Downers Grove, Ill.
Champ Industries Inc., P. O. Box 6736, Philadelphia 32, Pa.
Chase Bag Co., 155 E. 44th St., New York 17, N. Y.
Cheatham Elec. Switching Device Co., 4750 Crittenden Dr., Louisville 9, Ky., ADV. p410
Chelsea Fan and Blower Co., Inc., 639 South Ave., Plainfield, N. J.
Chevrolet Motor Div., General Motors Bldg., Detroit 2, Mich.
Chicago Eye Shield Co., 2727 W. Roscoe St., Chicago 18, Ill.
Chicago Perforating Co., 2445 West 24 Pl., Chicago 8, Ill.
Chicago Pneumatic Tool Co., 8 East 44 St., New York, N. Y., ADV. pp88-89
Chikaan Co., 330 N. Pomona Ave., Brea, Calif.
J. D. Christian Engineers, 480 Potrero Ave., San Francisco 10, Calif.
The Cincinnati Electrical Tool Co., 360 Mt. Hope Ave., Cincinati 4, Ohio.
Cincinnati Mine Machinery Co., 2980 Spring Grove Ave., Cincinnati 25, Ohio, ADV. p175
Cincinnati Rubber Mfg. Co., Div., of Thor Power Tool Co., Franklin Ave., Cincinnati 12, Ohio
Circle Wire & Cable Corp., 5500 Maspeth Ave., Maspeth 78, N. Y.
Circuit Protective Devices Dept., General Electric Co., 41 Woodford Ave., Plainville, Conn.
Cities Service Oil Co., 60 Wall Tower, New York 5, N. Y.
Clarage Fan Co., 619 Porter St., Kalamazoo 16, Mich.
Clark Controller Co., 1146 E. 152nd St., Cleveland 10, Ohio
Clark Equipment Co., Construction Machinery Div., P. O. Box 599, Benton Harbor, Mich.
Clark Equipment Co., Automotive Div., Buchanan, Mich.
Clayton Manufacturing Co., P. O. Box 550, El Monte, Calif.
Cleveland Vibrator Co., 2828 Clinton Ave., Cleveland, Ohio
Cleveland Wire Cloth & Mfg. Co., 3573 E. 78th St., Cleveland 5, Ohio
Cleveland Worm & Gear Co., 2300 East 80 St., Cleveland 4, Ohio
Clyde Iron Works, Inc., Duluth, Minn.
Coal Machinery Research, Inc., Box 66, Pecks Mill, W. Va.
Coast Metals, Inc., Redneck Ave., Little Ferry, N. J.
Cobra Metal Hose, Div. DK Mfg. Co., 5059 S. Kedzie Ave., Chicago 32, Ill.
Coffing Hoist Div., Duff-Norton Co., 800 Walter St., Danville, Ill.
Collier Carbon and Chemical Corp., 714 W. Olympic Blvd., Los Angeles 15, Calif.
Collyer Insulated Wire Co., 249 Roosevelt Ave., Pawtucket, R. I, ADV. p51
Colorado Fuel & Iron Corp., Continental Oil Bldg., Denver, Colo.; Wickwire Spencer Steel Div., 575 Madison Ave., New York 22, N. Y., ADV. p143
Columbia-Southern Chemical Corp., One Gateway Center, Pittsburgh 22, Pa.
Columbus McKinnon Chain Corp., Mining Equipment Div., Tonawanda, N. Y.
Combustion Engineering, Inc., 200 Madison Ave., New York 16, N. Y.
Combustion Engineering, Inc., Raymond Div., 1132 W. Blackhawk St., Chicago 22, Ill., ADV. p102
Commercial Shearing & Stamping Co., 1775 Logan Ave., P. O. Box 239, Youngstown 1, Ohio
Commercial Testing & Engineering Co., Suite 924, 228 North LaSalle St., Chicago 1, Ill.
Compton, Inc., P. O. Box 1946, Clarksburg, W. Va., ADV. p163
Concordia Electric Co., 1521 Saw Mill Run Blvd., Pittsburgh 10, Pa.
Cone-Drive Gears Div., Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.
Connellsville Mfg. & Mine Supply Co., Connellsville, Pa., ADV. p38
R. Conrader Co., Inc., 236 West 17th St, P. O. Box 924, Erie, Pa.
Construction Machy. Co., P. O. Box 120, Waterloo, Iowa
Continental Gin Co., Ind. Div, 4505—5th Ave So., Birmingham, Ala.
Continental Motors Corp., 205 Market St., Muskegon, Mich.
Continental Rubber Works, 1935 Liberty St., Erie 6, Pa.
Convair, P. O. Box 9671, Pittsburgh 26, Pa.
Copperweld Steel Co., Wire & Cable Div., Glassport, Pa.
Coppus Engineering Corp., 344 Park Ave., Worcester 10, Mass.
Corhart Refractories Co., Sub. of Corning Glass Works, 940 Commonwealth Bldg., Louisville 2, Ky.
Cornell-Dubilier Electric Corp., South Plainfield, N. J.
Cornish Wire Co., Inc., 50 Church St., New York 7, N. Y.
Cowanesque Valley Iron works, 960 Elm St., Cowanesque, Pa.
Cowin & Co., Inc., 1 18th St., SW, Birmingham, Ala.
Cox & Stevens Electronic Scales Div., Revere Corp. of America, Wallingford, Conn.
Crane Co., 836 S. Michigan Ave., Chicago 5, Ill.
Crescent Belt Fastener Co., 391 Fourth Ave., New York 16, N. Y., ADV. p372
Crosby-Laughlin Div., American Hoist & Derrick Co., Fort Wayne 1, Ind.
Cross Perforated Metals Plant, National Standard Co., Carbondale, Pa., ADV. p393
Crouse-Hinds Co., Syracuse 1, N. Y.
Crucible Steel Co. of America, Henry W. Oliver Bldg., Mellon Sq., Pittsburgh 22, Pa.
Cummins Engine Co. Inc., Columbus, Ind.
Cutler-Hammer, Inc., 220 N. 12th St., Milwaukee 1, Wis.
Cutter Bit Service Co., 111 West 8th Ave., P. O. Box 533, Huntington, W. Va.

D

D-A Lubricant Co, Inc., 1331 West 29 St., Indianapolis 23, Ind.
Dallas Engineers, Inc., Coal-O-Matic Div., Main St., Trucksville, Pa.
Daly Ticket & Printing Co., 506-08 Vandalia St., Collinsville, Ill.
The Dana Fan & Blower Corp., Gen Offices—49 Central Ave., Cincinnati 2, Ohio; Plant—2644 Colerain Ave., Cincinnati 14, Ohio
C. R. Daniels Co., Daniels, Md.
The Daniels Co., Contractors, Inc., 22 North Fifth St., Indiana, Pa.
Darworth Incorporated, Chemical Products Div., Simsbury, Conn.
Davey Compressor Co., 600 Franklin Ave., Kent, Ohio, ADV. p434
Nelson L. Davis Co., 517 Main St., McHenry, Ill.
Day-Ray Products, Inc., 1133 Missions St., South Pasadena, Calif.
Dayton Automatic Stoker Co., 1910 W. Dorothy Lane, Box 2186, Kettering Branch, Dayton 29, Ohio
Dayton Industrial Products Co., 2001 Janice Ave., Melrose Park, Ill.
Dean Brothers Pumps Inc., 323 West Tenth St., Indianapolis 7, Ind.
The Deister Concentrator Co., Inc., 901 Glasgow Ave., Ft. Wayne 1, Ind., ADV. p44
Deister Machine Co., 1933 E. Wayne St., Ft. Wayne 4, Ind.
Delta-Star Electric Div., H. K. Porter Co., Inc., 2437 Fulton St., Chicago 12, Ill.
The Deming Co., Salem, Ohio
Denison Engineering Div., American Brake Shoe Co., 1160 Dublin Rd., Columbus 16, Ohio
Denver Equipment Co., P. O. Box 5628, Denver 17, Colo.
Diamond Chain Co., Inc., 402 Kentucky Ave., Indianapolis 7, Ind.
Diamond Crystal Salt Co., St. Clair, Mich.
Diamond Iron Works, Div. Goodman Mfg. Co., Halsted St. & 48th Pl., Chicago 9, Ill.
Diamond Power Specialty Corp., Electronics Div., Lancaster, Ohio
Diamond Tool Research Co., Inc., 380 Second Ave., New York 10, N. Y.
Diehl Mfg. Co., 1208 Finderne Ave., Somerville, N. J.
Diesel Energy Corp., 82 Beaver St., New York, N. Y.
Differential Steel Car Co., Differential Ave., Findlay, Ohio, ADV. p146
Dings Magnetic Separator Co. 4724 W. Electric Ave., Milwaukee 46, Wis.
Disston Div., H. K. Porter Co., Inc., Philadelphia 35, Pa.
Joseph Dixon Crucible Co., Monmouth & Wayne Sts., Jersey City 3, N. J.
Dodge Div., Chrysler Corp., 7900 Jos. Campau, Detroit 31, Mich., ADV. p190
Dodge Mfg Corp., South Union St., Mishawaka, Ind.
Dominick & Dominick, 14 Wall St., New York 5, N. Y., ADV. p412
Dooley Brothers, 1201 S. Washington St., Peoria, Ill.
Dorr-Oliver Incorporated, 77 Havemeyer Lane., Stamford, Conn., ADV. pp22-23
The Dow Chemical Co., Midland, Mich.
Dow Corning Corp., Midland, Mich.
Dowty Mining Equipment Ltd., Cheltenham, England
Dravo Corp., Neville Island, Pittsburgh 25, Pa., ADV. p180
Drawalloy Corp., Lincoln Highway West at Alloy St., York, Pa.
Dresser Mfg. Div., Dresser Industries, Inc., Bradford, Pa.
The Ducon Co., Inc., 154 E. Second St., Mineola, N. Y.
Duff-Norton Co., 2709 Preble Ave., Pittsburgh, 30, Pa.
E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Del., ADV. p409
Duquesne Mine Supply Co., Pittsburgh 9, Pa.
Durakool, Inc., 1010 North Main St., Elkhart, Ind.
The Duriron Co., Inc., 450 North Findlay St., Dayton 4, Ohio
Dynamatic Div., Eaton Mfg. Co., 3122 Fourteenth Ave., Kenosha, Wis.

E

Eagle Iron Works, 161 Holcomb Ave, Des Moines 4, Iowa
Eaton Mfg. Co., Axle Div., 739 East 140th St., Cleveland 10, Ohio
Eavenson, Auchmuty & Greenwald, 2320 Koppers Bldg., Pittsburgh 19, Pa.
Economy Fuse & Mfg. Co., 2717 N. Greenview Ave., Chicago 14, Ill.
Thomas A. Edison Industries, McGraw-Edison Co., Storage Battery Div., West Orange, N. J.
Eimco Corp., 630 South 4th West St., Salt Lake City 10, Utah
Elastic Stop Nut Corp. of America, 2330 Vauxhall Rd., Union, N. J.
Electric Machinery Mfg. Co., 806 Central Ave., Minneapolis 18, Minn.
Electric Products Co., 1725 Clarkstone Rd., Cleveland 12, Ohio
Electric Steel Foundry Co., 2141 N. W. 25th Ave., Portland 10, Oregon
The Electrical Distributors Co., Penn Square Building, Philadelphia 7, Pa.
Electro-Alloys Div., American Brake Shoe Co., Taylor St. & Abbe Rd., Elyria, Ohio
Electro Dynamic Div. of General Dynamics Corp., 163 Avenue A, Bayonne, N. J.
Elliott Co., 900 N. Fourth Ave., Jeannette, Pa.
Elliott Service Co., Inc., 30 N. MacQuesten Pkwy., Mt. Vernon, N. Y.
The Elreco Corp., 2900 Cormany Ave., Cincinnati 25, Ohio

Emglo Products Corp., 116 Dupont St., Johnstown, Pa.
The Ensign-Bickford Co., P. O. Box 308, Simsbury, Conn.
Ensign Electric & Mfg. Co., 914 Adams Ave., Huntington, W. Va., ADV. p411
Enterprise Wheel & Car Corp., Bristol, Va., ADV. p103
Erico Products, Inc., 2070 E. 61 Pl., Cleveland 3, Ohio
Erie Manufacturing Co., 228 Magnet Drive, Erie, Pa.
Esso Standard Oil Co., 15 West 51 St., New York, N.Y.
Eutectic Welding Alloys Corp., 40-40 172 St., Flushing 58, N. Y.
Exide Industrial Div., The Electric Storage Battery Co., Rising Sun and Adams Aves., Philadelphia 2, Pa., ADV. p152
Extremultus, Inc., 405 Lexington Ave., New York 17, N. Y.

F

FWD Corp., E. 12th St., Clintonville, Wis.
The Fafnir Bearing Co., 37 Booth St., New Britain, Conn.
George E. Failing Co., Sub. of Westinghouse Air Brake Co., Enid, Okla.
The Fairbanks Co., 393 Lafayette St., New York 3, N. Y.
Fairbanks Morse & Co., 606 S. Michigan Ave., Chicago 5, Ill., ADV. p156
Fairchild Aerial Surveys, Inc., 224 E. 11th St., Los Angeles 15, Calif.
Fairmont Machinery Co., Fairmont, W. Va., ADV. p145
Fairview Bit Co., Fairview, W Va.
The Falk Corp., Box 492, Milwaukee 1, Wis., ADV. p42
Farrel-Birmingham Co., Inc., 25 Main St., Ansonia, Conn.
Farrell-Cheek Steel Corp., Sandusky, Ohio, ADV. p415
Farris Flexible Valve Corp., 400 Commercial Ave., Palisades Park, N. J.
Farval Corp., 3300 East 80th St., Cleveland 4, Ohio
The Federal Bearings Co., Inc., Poughkeepsie, N. Y.
Federal-Mogul Service, Div. Federal-Mogul Bower Bearings, Inc., 11031 Shoemaker Ave., Dertoit 13, Mich., ADV. p54
Femco, Inc., Irwin, Pa., ADV. p31
Fetterman Engineering Co. 1004 Jtwn. Bank & Trust Bldg., Johnstown, Pa.
Filter Fabrics, Inc., 814 E. Jefferson St., Goshen, Ind.
Firth Sterling, Inc., 3113 Forbes St., Pittsburgh 30, Pa.
Fischer & Porter Co., 505 Warminster Rd., Hatboro, Pa.
Fisher Scientific Co., 717 Forbes Ave., Pittsburgh 19, Pa.
J. H. Fletcher & Co., P.O. Box 2143 Huntington 18, W. Va.
Flexaust Co., 100 Park Ave., New York 17, N. Y.
Flexible Steel Lacing Co., 4607 Lexington St., Chicago 44, Ill.
Flexo Products, Inc., Westlake, Ohio
John Flocker & Co., 644 Grant St., Pittsburgh 19, Pa.
Flood City Brass & Electric Co., Messenger & Elder Sts., Johnstown, Pa., ADV. p163
The Fly Ash Arrestor Corp., P.O. Box 1883, Birmingham 1, Ala.
Foote Brothers Gear & Machinery Corp., 4545 South Western Blvd., Chicago, Ill.
Foote Mineral Co., 18 W. Chelten Ave., Philadelphia 44, Pa.
Ford Div. of Ford Motor Co., P. O. Box 858, Dearborn, Mich.
Foster Wheeler Corp., 666 Fifth Ave., New York 19, N. Y.
Foxboro Co., Foxboro, Mass.
Franklin Plastics Inc., 315 Grant St., Franklin, Pa.
Fred's Welding Service, P. O. Box 178, Grundy, Va.
The Frick-Gallagher Mfg. Co., 110 S. Michigan Ave., Wellston, Ohio
Fuel Process Co., 900 D St., South Charleston, W. Va.
Fuller Mfg. Co., 1419 North Burdick St., Kalamazoo, Mich.
Fulton Cotton Mills, P. O. Box 1726, Atlanta 1, Ga.
The Fyr-Fyter Co., 221 Crane St., Dayton 1, Ohio

G

GM DIESEL, Detroit Diesel Engine Div., General Motors Corp., 13400 West Outer Drive, Detroit 28, Mich.
G & W Electric Specialty Co., 3500 W. 127 St., Blue Island, Ill.
Galigher Co., 545 West 8th South, P. O. Box 209, Salt Lake City 10, Utah
Galion Allsteel Body Co., Galion, Ohio
Galion Iron Works & Mfg. Co., 605 S. Market St., Galion, Ohio
Galis Electric & Machine Co., P. O. Box 2027 WO, Morgantown, W. Va., ADV. p56
Gardner-Denver Company, Quincy, Ill.
The Garlock Packing Co., 402 East Main St. Palmyra, N. Y.
Gar Wood Industries, Inc., Wayne, Mich.
The Gates Rubber Co. Sales Div., Inc., 999 South Broadway, Denver 17, Colo.
General Cable Corp., 420 Lexington Ave., New York 17, N. Y.
General Electric Co., Apparatus Sales Div., 1 River Road, Schenactady 5, N. Y., ADV. pp394-395
General Electric Co., Chemical and Metallurgical Div., Insulating Materials Dept., 23 River Rd., Schenectady 5, N. Y.
General Electric Co., Communication Products Dept., Lynchburg, Va.
General Electric Co., Wire and Cable Dept., Conduit Products Dept., 1285 Boston Ave., Bridgeport, Conn.
General Electric Co., Lamp Div., Nela Park, Cleveland, Ohio
General Electric Co., Locomotive & Car Equipment Dept., 2901 E. Lake Rd., Erie 1, Pa.
General Equipment & Manufacturing Co., 116 S. Campbell St., Louisville 6, Ky., ADV. p407
General Logistics, 2929 Floyd St., Burbank, Calif.
General Motors Corp., Euclid Division, 1361 Chardon Road, Cleveland 17, Ohio
General Scientific Equipment Co., Limekiln Pike & Williams Ave., Philadelphia 50, Pa.
General Splice Corp., 85 Spring St., South Norwalk, Conn.
Gensco Tools Div., General Steel Warehouse Co., Inc., 1830 N. Kostner Ave., Chicago 39, Ill.
The Geodimeter Co., 1170 Broadway, New York 1, N. Y.
Geo Optic & Paper Corp., 149 Church St., New York 7, N. Y.
Gering Products, Inc., North Seventh St. and Monroe Ave., Kenilworth, N. J.
Gibraltar Equipment & Mfg. Co., P. O. Box 304, Alton, Ill.
M. Glosser & Sons Inc., 80 Messenger St., Johnstown, Pa.
Goodall Rubber Co., Whitehead Rd., Trenton, N. J.
Goodman Mfg. Co., Halsted St. & 48th Place, Chicago 9, Ill., ADV. Insert pp17, 18
B. F. Goodrich Chemical Co., 3135 Euclid Ave., Cleveland 15, Ohio
B. F. Goodrich Industrial Products Co., 500 South Main St., Akron 18, Ohio, ADV. p1
B. F. Goodrich Tire Co., A Div. of the B. F. Goodrich Co., Arkon, Ohio, ADV. p139
Goodyear Tire & Rubber Co., 1144 East Market St., Akron 16, Ohio
The Gorman-Rupp Co., 305 Bowman St., Mansfield, Ohio, ADV. p431
Gould-National Batteries, Inc., Trenton 7, N. J.
Goulds Pumps, Inc., Seneca Falls, N. Y.
Goyne Pump Co., Ashland, Pa.
Gray & Co., Inc., 56 Eleventh Ave., N. E., Minneapolis 13, Minn.
Grinnell Co., 260 West Exchange St., Providence 1, R.I.
Gruendler Crusher & Pulverizer Co., 2915 No. Market St., St. Louis 6, Mo.
Gulf Oil Corp., Gulf Bldg., Pittsburgh 19, Pa.
T. J. Gundlach Machine Co., Div. J. M. J. Industries, Inc., P. O. Box 243, Belleville, Ill., ADV. p359
Gurley, W. & L. E., 1904 Fifth Ave., Troy, N. Y.
Gustin-Bacon Mfg. Co., 210 West Tenth St., Kansas City, Mo.
Guyan Machy. Co., 755 Stratton, Logan, W. Va., ADV. p427

H

H & L Tooth Co., 1540 South Greenwood Ave., Montebello, Calif., ADV. p363
Hackbridge & Hewittic Electric Co., Ltd., P. O. Box 234, Pittsburg 30, Pa.
Hagan Chemicals & Controls, Inc., P. O. Box 1346, Pittsburgh 30, Pa.
Hammermills, Inc., 625 C. Ave., N. W., Cedar Rapids, Iowa
J. V. Hammond Co., Spangler, Pa.
F. R. Hannon & Sons, Canton 7, Ohio
Hardinge Co., Inc., 240 Arch St., York, Pa.
Harnischfeger Corp., 4400 W. National Ave., Milwaukee 46, Wis. ADV. pp24-25
The Harrington & King Perforating Co., Inc., 5655 W. Fillmore St., Chicago 44, Ill.
Hauck Mfg. Co., 144-154 Tenth St., Brooklyn 15, N. Y.
The Hauser-Stander Tank Co., 4838 Spring Grove Ave., Cincinnati 32, Ohio, ADV. p142
Herb J. Hawthorne, Inc., Box 7366, Houston 8, Tex.
Hays Corp., 742 E. 8th St., Michigan City, Ind.
The Heil Co., TEC Div., 1285 W. 70th St., Cleveland 2, Ohio
Heintz Mfg. Co., 13110 Enterprise Ave., Cleveland, Ohio
Helicoid Gage Div., American Chain & Cable Co., Inc., Bridgeport 2, Conn.
Helmick Foundry-Machine Co., P. O. Box 71, Fairmont, W. Va.
Helwig Carbon Products, Inc., 2500 N. 30th St., Milwaukee 10, Wis.
Hendrick Mfg. Co., Carbondale, Pa., ADV. pp34, 384
Hendrickson Mfg. Co., 8001 W. 47th St., Lyons, Ill.
Hendrix Mfg. Co., P. O. Box 31, Mansfield, La.
Hercules Motors Corp., 101 11 St., S. E., Canton, Ohio
Hercules Powder Co., Delaware Trust Bldg., 900 Market St., Wilmington, Del., ADV. p429
Hercules Steel Products Co., Galion, Ohio
Herold Mfg. Co., 215 Hickory St., Scranton 5, Pa.
Hevi-Duty Electric Co., 2040 W. Wisconsin Ave., Milwaukee 1, Wis.
Hewitt-Robins Incorporated, 666 Glenbrook Rd., Stamford, Conn.
The Hewson Co., Inc., 443 Broad St., Newark 2, N. J.
Heyl & Patterson, Inc., 55 Fort Pitt Blvd., Pittsburgh 22, Pa., ADV. p41
Hobart Bros. Co., Hobart Square, Troy 1, Ohio
Hockensmith Corp., Penn, Pa.
Hodag Chemical Corp., 7247 North Central Park, Chicago 45, Ill.
Hoffman Brothers Drilling Co., Tiona and Cedar Sts., Punxsutawney, Pa.
Hoffman Combustion Engrg. Co., 1780 Southfield Rd., Lincoln Park, Mich.
Robert Holmes & Bros., Inc., 510 Junction Ave., Danville, Ill.
Holub Industries, Inc., 413 DeKalb Ave., Sycamore, Ill.
Homelite, a division of Textron, Inc., 75 Riverdale Ave., Port Chester, N. Y.
The Homer Mfg. Div., The Ohio Electric Mfg. Co., 142 E. Pearl St., Lima, Ohio
Homestead Valve Mfg. Co., Coraopolis, Pa.
Hose Accessories Co., 17th St. & Lehigh Ave., Philadelphia 32, Pa.
Hossfeld Mfg. Co., 460-462 W. Third St., Winnona, Minn.
The Frank G. Hough Co., 725 Seventh St., Libertyville, Ill.
Howe Scale Co., Rutland, Vt.
Howells Mining Drill Co., Plymouth, Pa.
Hoyt Wire Cloth Co., P. O. Box 1577, Lancaster, Pa., ADV. p357
Huber-Warco Co., Marion, Ohio, ADV. p391
Hughes Tool Co., 5425 Polk Ave., Houston, Tex.
Hulburt Oil & Grease Co., Trenton & Castor Ave., Philadelphia 34, Pa.
Hunt Valve Co., 1900 E. Pershing, Salem, Ohio
Hyatt Bearings Div., General Motors Corp., Harrison, N. J.
Hydreco Div., The New York Air Brake Co., 9000 E. Michigan Ave., Kalamazoo, Mich.
Hyster Co., 2903-39 N.E. Clackamas St., Portland 8, Ore.
Hy-Test Safety Shoe Div., International Shoe Co., 1509 Washington Ave., St. Louis 66, Mo.

I

I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia 30, Pa.
Ideal Industries, Inc., 1020 Park Ave., Sycamore, Ill.
Ideal-Simplet Fittings, Div. of Ideal Industries, Inc., 1020 Park Ave., Sycamore, Ill.
Ilg Electric Ventilating Co., 2850 N. Pulaski Rd., Chicago 41, Ill.
Illinois Zinc Co., 2959 W. 47th St., Chicago 32, Ill.
Imperial-Cantrell Mfg. Co., P.O. Box 538, Jellico, Tenn.
Industrial Chemicals Div., Spencer Chemical Co., Dwight Bldg., Kansas City 5, Mo., ADV. p167
Industrial Physics & Electronics Co., Inc., First National Bank Bldg., Fairmont, W. Va.
Industrial Nucleonics Corp., 650 Ackerman Rd., Columbus 14, Ohio
Industrial Physics & Electronics, Co., 470 So. 10th East, Salt Lake City, Utah
Industrial Rubber Products Co., 815 Court St., Charleston, W. Va.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp., Box 840, Lansing, Mich.
Infilco Inc., P. O. Box 5033, Tucson, Ariz.
Ingersoll-Rand Co., 11 Broadway New York 4, N. Y., ADV. p379
Inland Steel Co., 30 W. Monroe St., Chicago 3, Ill.
Insley Mfg. Corp., 801 N. Olney St., Indianapolis 1, Ind.; General Offices—Indianapolis, Ind.; West Coast Div.—Los Angeles, Calif.
Instrument Div., Gichner, Inc., 1900 Kendall St., N.E., Washington 2, D. C.
International Harvester Co., Construction Equipment Div., North Ave. and Mannheim Rd., Melrose Park, Ill., ADV. pp68-69
International Harvester Co., Motor Truck Div., 180 N. Michigan Ave., Chicago 1, Ill.
International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.
International Salt Co., Inc., P.O. Drawer 511, Scranton 2, Pa.
Interstate Equipment Corp., 453 N. Broad St., Elizabeth 3, N. J.
Iowa Mfg. Co., 916 16 St., N.E., Cedar Rapids, Iowa
Ironton Engine Co., Farmingdale, N. J.
Irwin-Sensenich Corp., Box 311, Irwin, Pa.
Irvington Div. of Minnesota Mining & Mfg. Co., St. Paul, Minn.

J

Jeffrey Mfg. Co., 922 N. Fourth St., Columbus 16, Ohio, ADV. pp35, 36
Jenkins Bros., 100 Park Ave., New York 17, N. Y.

Johns-Manville, 22 East 40 St., New York 16, N. Y.
Johnson Bronze Co., 492 S. Mill St., New Castle, Pa.
The Johnson-March Corp., 3018 Market St., Philadelphia 4, Pa.
Johnson Plastic Corp., P. O. Box 100, Chagrin Falls, Ohio
G. R. Johnson Loading Supplies, 5026 Butterworth Rd., Mercer Island, Wash.
The R. G. Johnston Co., 25 S. College St., Washington, Pa.
Johnston Pump Co., Div. of The Youngstown Sheet and Tube Co., P. O. Bin K, Pasadena, Calif.
Jones & Laughlin Steel Corp., 3 Gateway Center, Pittsburgh 30, Pa.
Joy Mfg. Co., 333 Oliver Bldg., Pittsburgh 22, Pa.; Coal Machy. Div. 4107 Senott St. Pittsburgh, 13 Pa.; 742 Eighth Ave., P. O. Box 1208, Huntington 14, W. Va.; Box 1152, Kingston, Pa.; 1203 Macklind Ave., St. Louis, 10, Mo.; 1626 Wazee St., Denver 2, Colo., ADV. pp151, 157, 158, 159, 160, 410
Joyce-Cridland Co., 2027 East 1st St., Dayton, Ohio
Judsen Rubber Works, Inc., 4107 West Kinzie St., Chicago 24, Ill.

K

K-W Dart Truck Co., 1301 N. Manchester Tfwy., Kansas City 20, Mo., ADV. p144
Kaiser Aluminum & Chemical Sales, Inc., 99 N. Michigan Ave., Chicago 11, Ill.
Kanawha Mfg. Co., Charleston 26, W. Va.
Keasbey & Mattison Co., Ambler, Pa.
Keenan Oil Co., Parkway Dr., Cincinnati 12, Ohio
Kelly Mfg. Co., Machine Parts Div., 503-505 Broad St., Charleston 21, W. Va.
Kennametal, Inc., Mining Tool Div. Bedford, Pa., ADV. pp20-21
Kennedy Valve Mfg. Co., Elmira, N. Y.
Kennedy Van Saun Mfg. & Eng. Corp., 405 Park Ave., New York 22, N. Y.
Kensington Steel, Div. of Poor & Co., 505 Kensington Ave., Chicago 28, Ill.
Kern Instruments Inc., 120 Grand St., White Plains, N. Y.
Kersey Manufacturing Co., Inc., P. O. Box 151, Bluefield, Va., ADV. p166
Keystone Carbon Co., 1935 State St., St. Marys, Pa.
Keystone Lubricating Co., 21 & Clearfield Sts., Philadelphia 32, Pa.
Walter Kidde & Co., Inc., 356 Main St., Belleville 9, N. J.
Kidde Ultrasonic & Detection Alarms, Inc., 356 Brighton Rd., Allwood Station, Clifton, N. J.
S. P. Kinney Engineers, Inc., 201 Second Ave., Carnegie, Pa.
Kinney Mfg. Div., The New York Air Brake Co., 3529 Washington St., Boston 30, Mass.
Kirk & Cowin, Inc., 1 18th St., SW, Birmingham, Ala.
Koehring Div. of Koehring Co., 3026 W. Concordia Ave., Milwaukee 16, Wis.
Koppers Co. Inc., Metal Products Div., 200 Scott St., Baltimore 3, Md.
Koppers Co., Inc., Wood Preserving Div., 750-A Koppers Bldg., Pittsburgh 19, Pa., ADV. p182
Koven Fabricators, Inc., 90 E. Dickerson St., Dover, N. J.
Kremser & Sons, Inc., Frank A., P. O. Box 6207, Holmesburg Station, Philadelphia 36, Pa.
Kuhlman Elec. Co., 2565 E. Maple Rd., P. O. Box 288, Birmingham, Mich.

L

Laboratory Equipment Corp., St. Joseph, Mich.
LaBour Co., Inc., 1607 Sterling Ave., Elkhart, Ind.
Laclede Stoker Co., 4444 Hunt Ave., St. Louis 10, Mo.
Ladish Co., 5481 S. Packard Ave., Cudahy, Wis.
Lancaster Pump & Mfg. Co., Inc., Lancaster, Pa.
Laubenstein Mfg. Co., Ashland, Pa.
Layne & Bowler, Inc., Box 6697, Hollywood Sta., Memphis 8, Tenn.
Layne & Bowler Pump Co., P. O. Box 6991, Los Angeles 22, Calif.
Lecco Machinery & Engineering Co., P. O. Box 1337, New Airport Rd., Bluefield, W. Va.
Ledeen, Inc., 3350 No. Gilman Rd., El Monte, Calif.
Lee-Norse Co., Charleroi, Pa., ADV. p55
The Leetonia Tool Co., 142 Main St., Leetonia, Ohio
Leman Machine Co., S. Railroad St., Portage, Pa., ADV. p186
Le Roi Div., Westinghouse Air Brake Co., Milwaukee 1, Wis., ADV. p101
Leschen Wire Rope Div., H. K. Porter Co., Inc., 2727 Hamilton Ave., St. Louis 12, Mo., ADV. p62
R. G. LeTourneau Inc., 2395 S. MacArthur, Longview, Texas
LeTourneau - Westinghouse Co., 2361 N.E. Adams St., Peoria, Ill., ADV. pp57, 59
Linatex Corp. of America, Drawer "D" Stafford Springs, Conn., ADV. p70
The Lincoln Electric Co., 22801 St. Clair Ave., Cleveland 17, Ohio
Lincoln Engrg. Co., Div. of McNeil Mach. & Engrg. Co., 5701 Natural Bridge Ave., St. Louis, Mo., ADV. pp354-355
Link-Belt Co., Dept CAMGL-59, Prudential Plaza, Chicago 1, Ill., ADV. Fourth Cover
Link-Belt Speeder Corp., Cedar Rapids, Iowa
Lippmann Engineering Works Inc., 4603 West Mitchell St., Milwaukee 14, Wis.
Herbert S. Littlewood, R. D. 3, Irwin, Pa.
Peter F. Loftus Corp., First National Bank Bldg., Pittsburgh 22, Pa.
The Lone Co., P. O. Box 331, Oak Hill, W. Va., ADV. p2-3
Lubriplate Div., Fiske Brothers Refining Co., 129 Lockwood St., Newark 5, N. J.
Ludlow Sayler Wire Cloth Co., 634 South Newstead, St. Louis 10, Mo., ADV. p351
Ludlow Valve Mfg. Co., Inc., P. O. Box 388, Troy 1, N. Y.
Lufkin Rule Co., 1730 Hess Ave., Saginaw, Mich.
Lukens Steel Co., 356 Lukens Bldg., Coatesville, Pa., ADV. p183
The Lunkenheimer Co., Beekman St. and Waverly Ave., Cincinnati 14, Ohio

M

Machinery Center, Inc., 1201 S. Sixth West St., Salt Lake City, Utah
Mack Trucks, Inc., 1355 West St., Plainfield, N. J., ADV. p187
Macwhyte Wire Rope Co. 2931 14th Ave., Kenosha, Wis.
Magic Chemical Co. 121 Crescent St., Brockton 2, Mass.
Magnetic Engrg. & Mfg. Co., 851 Van Houten Ave., Clifton, N.J.
Majac, Inc., Sub. of Blackstone Corp., 23rd St., Sharpsburg, Pittsburgh 15, Pa.
Mancha Storage Battery Locomotive, div. Goodman Mfg. Co., Halsted St., & 48th Pl., Chicago 9, Ill.
Manheim Mfg. & Belting Co., 470 Stiegel St., Manheim, Pa.
Manitowoc Engineering Corp., S. 16th St., Manitowoc, Wis., ADV. p170
Charles E. Manning Co., 4700 Clairton Blvd., Pittsburgh 36, Pa.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div., Muskegon, Mich.
Manzel Div., Houdaille Industries, Inc., 215 Babcock St., Buffalo 10, N. Y.
Marathon Coal Bit Co., Inc., Box 391, Montgomery, W. Va.
Marietta Concrete, Div. of American-Marietta Co., Box 356, Marietta, Ohio, ADV. p380
Marietta Manufacturing Co., P.O. Box 17, Point Pleasant, W. Va.
Marion Handle Mills, Inc., Marion, Va.
Marion Metal Products, Co., Chancy Ave., Marion, Ohio
Marion Power Shovel Co., a div. of Universal Marion Corp., Marion, Ohio, ADV. p33
Marland One-Way Clutch Co., Elm Ave. & Washington St., La Grange, Ill.
Marlin-Rockwell Corp., 402 Chandler St., Jamestown, N. Y.
Marlow Pumps, Div. of Bell & Gossett Co., Box 200, Midland Park, N. J.
Marman Div., Aeroquip Corp., 11214 Exposition Blvd., Los Angeles 64, Calif.
E. F. Marsh Engrg. Co., 4324 W. Clayton Ave., St. Louis 10, Mo.
Martin Engrg. Co., Cab Road, Neponset, Ill.
Martindale Electric Co., 1307 Hird Ave., Cleveland 7, Ohio
Master Bronze Powder Co., Inc., 538-548 W. State St., Calumet City, Ill.
The Master Electric Co., Div. of Reliance Electric & Engrg. Co., 126 Davis Ave., Dayton 1, Ohio
Mayo Tunnel & Mine Equipment, Lancaster, Pa.
McDowell Co., Inc., 113 St. Clair Ave., N.E., Cleveland 14, Ohio
McDowell Mfg. Co., Pittsburgh 9, Pa.
McLanahan & Stone Corp., Hollidaysburgh, Pa., ADV. p148
McLaughlin Mfg. Co., Inc., 801 E. Cass St., Joliet, Ill.
McNally-Pittsburg Mfg. Corp., 307 West Third St., Pittsburg, Kan., ADV., pp191, 192, 193, 194, 140
Meckum Engineering, Inc., 53 W. Jackson Blvd., Chicago 4, Ill.
Meissner Engineers, Inc., 300 W. Washington St., Chicago 6, Ill.
Merrick Scale Mfg. Co., 184 Autumn St., Passaic, N. J., ADV. p419
Metal Carbides Corp., 6001 Southern Blvd., Youngstown 12, Ohio
Metal & Thermit Corp., Rahway, N. J.
Metallurgical Products Dept., General Electric Co., Box 237, Roosevelt Park Annex, Detroit 32, Mich.
Mexico Refractories Co., Mexico, Mo.
Midland Pipe & Supply Co., 2829 S. 61st St., Chicago, Ill.
Mine Safety Appliances Co., 201 North Braddock Ave., Pittsburgh 8, Pa., ADV. pp60-61
The Mine & Smelter Supply Co., Manufacturing Div., P.O. Box 9401 (3800 Race St.), Denver, Colo.
Mine Ventilation Systems, Inc., Box 382, Madison, W. Va.
Miners Hardware Supply Co., 215 Martin Bldg. Pittsburgh 12, Pa., ADV. p420
Mining Machine Parts Inc., 2701 St. Clair Ave., Cleveland 14, Ohio
Mining Progress, Inc., P. O. Box 3, Highland Mills, N. Y.
Minneapolis-Honeywell Regulator Co., Industrial Division, Wayne and Windrim Ave., Phila. 44, Pa.
Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.
Mitchell Industrial Tire, Inc., Box 468, Chattanooga, Tenn.
Mobile Aerial Towers, Inc., 1730 N. Harrison St., Fort Wayne, Ind.
Mobile Drilling, Inc., 960 North Pennsylvania St., Indianapolis, 4, Ind.
Moloney Electric Co., 5390 Bircher Blvd., St. Louis 20, Mo.
Monsanto Chemical Co., 800 N. Lindbergh Blvd., St. Louis 66, Mo.
The Moore Co., 1036 Quarrier St., Charleston, W. Va.
Morris Machine Works, Baldwinsville, N. Y., ADV. p405
Morse Bros. Machinery Co., 2900 Brighton Blvd., Denver 1, Colo.
Morse Chain Co., A Borg-Warner Industry, Ithaca, N. Y.
Morton Salt Co., 110 No. Wacker, Chicago 6, Ill.
Mosebach Electric & Supply Co., 1115 Arlington Ave., Pittsburgh 3, Pa.
T. J. Moss Tie Co., 700 Security Bldg., St. Louis 2, Mo.
Motor Exchange and Supply Co., Hines, W. Va.
Motorola Communications & Electronics, Inc., 4501 West Augusta Blvd., Chicago 51, Ill.
Mott Core Drilling Co., 830 Eighth Ave., Huntington 17, W. Va.
Murphy Diesel Co., 5317 West Burnham St., Milwaukee, Wis.
Myers-Whaley Co., P. O. Box 789, Knoxville 1, Tenn.

N

Nachod & U. S. Signal Co., 4777 Louisville Ave., Louisville 9, Ky., ADV. p410
Nagle Pumps, Inc., 1237 Center Ave., Chicago Heights, Ill.
Nash Engineering Co., South Norwalk, Conn.
Nathan Mfg. Corp., 45-02 Ditmars Blvd., Long Island City 5, N. Y.
National Air Vibrator Co., 435 Literary Rd., Cleveland 13, Ohio
National Carbon Co., Division of Union Carbide Corp., 30 East 42nd St., New York 17, N. Y.
National Electric Coil Div., of McGraw-Edison Co., 800 King Ave., Columbus 16, Ohio, ADV. p185
National Electric Products Co., Gateway Center, Bldg. 2, 140 Stanwix St., Pittsburgh 22, Pa.
National Filter Media Corp., 1717 Dixwell Ave., New Haven 11, Conn.
National Malleable & Steel Castings Co., 18600 Quincy Ave., Cleveland 6, Ohio, ADV. p27
National Mine Service Co., 2530 Koppers Bldg., Pittsburgh 19, Pa.; Clarkson Div., Nashville, Ill.; Bemeco Div., Beckley W., Va.; All-State Div., Logan, W. Va.; Kentucky-Virginia Div., Jenkins, Ky.; Whiteman Div., Indiana, Pa.; Ashland Div., Ashland, Ky.; Anthracite Div., Forty Fort, Pa.; Western Kentucky Div., Madisonville, Ky.; Greensburg Div., Greensburg, Pa.; Mountaineer Div., Morgantown, W. Va; National Mine Service (Canada) Ltd. Elliot Lake, Ontario, ADV. p16
National Powder Co., Eldred, Pa.
National Supply Company, 2 Gateway Center, Pittsburgh, Pa.
National Tube Div., United States Steel Corp., 525 William Penn Place, Pittsburgh 30, Pa.
Naylor Pipe Co., 1262 E. 92 St., Chicago 19, Ill.
The Neff & Fry Co., 320 Elm St., Camden, Ohio
Newcomer Products, Inc., Latrobe, Pa.
New Departure Div., General Motors Corp., 269 N. Main St., Bristol, Conn.
New Jersey Meter Co., Inc., 350 Leland Ave., Plainfield, N. J.
New York Central System, 466 Lexington Ave., New York, N. Y. ADV p176.
New York & New Jersey Lubricant Co., 292 Madison Ave., New York 17, N. Y.
New York Rubber Co., 100 Park Ave., New York 17, N. Y., ADV. p161
Newark Wire Cloth Co., 351 Verona Ave., Newark 4, N J.
The Nolan Co., Bowerston, Ohio, ADV. p32
Nordberg Mfg. Co., 3073 South Chase Ave., Milwaukee 1, Wis.
Norma-Hoffman Bearings Corp., Stamford, Conn.
North American Machine Co., Blairsville, Pa.
Northwest Engineering Co., 135 S. La Salle St., Chicago 3, Ill.
Norton Co., 1 New Bond St., Worcester 6, Mass.
NoVo Div., Industrial Enterprises Inc., 9706 Cottage Grove Ave., Chicago 28, Ill.
B. J. Nykerk Corp., 42 Broadway, New York 4, N. Y.

O

Ohio Brass Co., Mansfield, Ohio, ADV. p127
Ohio Carbon Co., 12508 Beres Road, Cleveland 11, Ohio
Ohio Oil Co., Findlay, Ohio
Okonite Co., Canal St., Passaic, N. J. ADV. pp91, 150

Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div., East Alton, Ill.
The Oliver Corp., 400 West Madison St., Chicago 6, Ill.
Onox, Inc., 121 Second St., San Francisco 5, Calif.
Kurt Orban Co., Inc., Industrial Equipment Div., 22 W. Putnam Ave., Greenwich, Conn.
Ore & Chemical Corp., 80 Broad St., New York, N. Y.
Ore Reclamation Co., 301 No. Connell Ave., Picher, Okla.
Orefraction, Inc., 7425 Thomas St., Pittsburgh 8, Pa.
Orton Crane & Shovel Co., 608 S. Dearborn St., Chicago 5, Ill.
Osmose Wood Preserving Co., 980 Ellicott St., Buffalo 9, N. Y.

P

PLM Products, Inc., 3871 W. 150th St., Cleveland 11, Ohio, ADV. p40
Page Engineering Co., Clearing Post Office, Chicago 38, Ill.
Page Steel & Wire Div., American Chain & Cable Co., Inc., Monessen, Pa.
The Palnut Co., 31A Glen Road, Mountainside, N. J.
Paltech Co., 85 Spring St., South Norwalk, Conn.
Pangborn Corp., 2800 Pangborn Blvd., Hagerstown, Md.
Paris Mfg. Co., Paris, Ill.
Parker Fittings & Hose Div. and Parker Hydraulics Div., 17325 Euclid Ave., Cleveland 12, Ohio
The Parkersburg Rig & Reel Co., Div. of Parkersburg-Aetna Corp., 1958 Crawford St., Parkersburg, W. Va.
Pattin Mfg. Co., Marietta, Ohio
Peerless Photo Products, Inc., Shoreham, N. Y.
Peerless Pump Div., Food Machinery & Chemical Corp., 301 West Ave. 26, Los Angeles 31, Calif.
Penn Machine Co., 106 Station St., Johnstown, Pa., ADV. Second Cover
Pennsylvania Crusher Div., Bath Iron Works Corp., Room 1711, West Chester, Pa.
Pennsylvania Drilling Co., 1201 Chartiers Ave., Pittsburgh 20, Pa.; Masonry Drill Div., 1201 Banksville Rd., Pittsburgh 16, Pa.
Pennsylvania Electric Coil Corp., 1301 Saw Mill Run Blvd., Pittsburgh 26, Pa.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Pennsylvania Refining Co., Butler, Pa.
Perfection Steel Body Co., East St., Galion, Ohio
Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.
Peterson Filters & Engineering Co., 1949 S. Second West, Salt Lake City 10, Utah
Pettibone Mulliken Corp., Haiss Div., 1212 E. Dominick St., Rome N. Y.
J. B. Pfister Co., 662 Ohio St., Terre Haute, Ind.
Phelps Dodge Copper Products Co., 300 Park Ave., New York 22, N. Y.
Phoenix Steel Corp., Structural & Tube Divisions, Phoenixville, Pa.; Plate Div., Harrisburg, Pa.; Phoenix Bridge Co., Phoenixville, Pa.
Phoenix Products Co., Inc., 4737 North 27th St., Milwaukee 9, Wis., ADV. p142
Pierce Management Corp., P. P. & L. Bldg., Scranton 3, Pa.
Pioneer Engineering, Div. of Poor & Co., 3200 Como Ave., Minneapolis 14, Minn.
Pipe Linings, a Div. of American Pipe and Construction Co., P.O. Box 457, Wilmington, Calif.
Pitman Manufacturing Co., 300 West 79th Terrace, Kansas City 14, Mo.
Pittsburgh Corning Corp., 1 Gateway Center, Pittsburgh 22, Pa.
Pittsburgh Gear Co., Neville Island, Pittsburgh 25, Pa.
Pittsburgh Plate Glass Co., One Gateway Center, Pittsburgh 22, Pa.
Plymouth Locomotive Works, Div. of the Fate-Root-Heath Co., Plymouth, Ohio
Plymouth Rubber Co., Inc., 51 Revere St., Canton, Mass.
H. K. Porter Co., Connors Steel Div., West Virginia Works, P.O. Box 118, Huntington, W Va.; Connors Works, P. O. Box 2562, Birmingham, Ala., ADV. p64
H. K. Porter, Inc. 74 Foley St., Somerville, Mass.
Porto Pump, Inc. 19735 Ralston, Detroit 3, Mich.
The Post-Glover Electric Co., P.O. Box 709, Covington, Ky., ADV. p96
Preco Incorporated, 6300 E. Slauson Ave., Los Angeles 22, Calif.
Prime Mover Co., Muscatine, Iowa
K. Prins & Associates, Wellston, Ohio
Productive Equipment Corp., 2926 West Lake St., Chicago 12, Ill.
Proto Tool Co., Div. of Pendleton Tool Industries, Inc., 2209 Santa Fe Ave., Los Angeles, Calif.
Frank Prox Company, Inc., 1201 South 1st St., Terre Haute, Ind.
Pulmosan Safety Equip. Co., 644 Pacific St., Brooklyn, N. Y.
Pure Carbon Co., Inc., 441 Hall Ave., St. Marys, Pa.
The Pure Oil Co., 620 E. Broad St., Columbus, Ohio
Pyramid Industries, Inc., 1422 Irwin Drive, Erie, Pa.

Q

"Quick-Way" Truck Shovel Co., 2401 E. 40th Ave., Denver, Colo.

R

R-P & C Valve Div., American Chain & Cable Co., Inc., Reading, Pa.
Raybestos Manhattan, Inc., Manhattan Rubber Div., 42 Townsend St., Passaic, N. J. ADV. p401
Read, Davis, Consulting Engineer, 120 S. La Salle St., Chicago, Ill.
Red Jacket Co., Inc., 500 Bell Ave., Carnegie, Pa.
Reeves Pulley Co. Div., Reliance Electric & Engineering Co., 1225 7th St., Columbus, Ind.
REICHdrill Div., Chicago Pneumatic Tool Co., 1439 Ash St., Terre Haute, Ind.
Reid Belt & Rubber Co., 917 Grant St., Bluefield, W. Va.
Geo. P. Reintjes Co., P. O. Box 856, Kansas City 41, Mo
Reliance Elec. & Eng. Co., 24701 Euclid Ave., Cleveland 17, Ohio
Reliance Insurance Co., 401 Walnut St., Philadelphia 6, Pa.
Remaly Mfg. Co., Inc., Tamaqua, Pa.
Rema-Tech, Inc., 2 Park Ave., New York 16, N. Y.
Remington Arms Co., Inc., 939 Barnum Ave., Bridgeport 2, Conn.
Reo Div., The White Motor Co., 1331 South Washington St., Lansing 20, Mich.
Republic Creosoting Co., 1615 Merchants Bank Bldg., Indianapolis 4, Ind.
Republic Rubber Div., Lee Rubber & Tire Co., Youngstown 1, Ohio
Republic Steel, Republic Bldg., Cleveland 1, Ohio, ADV. pp188-189
Resisto-Loy Co., Inc., 1251 Phillips Ave., S.W., Grand Rapids 7, Mich.
Revere Copper & Brass, Inc., 230 Park Ave., New York 17, N. Y.
Reynolds Metals Co., 6601 W. Broad St., Richmond 19, Va., ADV. p147
Rice Pump & Machine Co., Belgium, Wis.
The Ridge Tool Co., 400 Clark St., Elyria, Ohio
Riegel Textile Corp., 260 Madison Ave., New York, N. Y.; Glove Div., Conover, N.C.
Robbins Machine & Mfg. Co., Inc., P.O. Box 28, Oneonta, Ala.
Robbins & Meyers, Inc., 1345 Lagonda Ave., Springfield, Ohio
Roberts & Schaefer Co., Div. Thompson-Starrett Co., Inc., 201 N. Wells, St., Chicago 6, Ill., ADV. p174
Robinson & Robinson, Union Bldg., Charleston, West Va.
Robinson Ventilating Co., Zelienople, Pa.
Rochester Ropes Inc., Culpeper, Va.
Rockbestos Products Corp., Sub. of Cerro de Pasco Corp., Nicoll and Canner Sts., New Haven 4, Conn.
Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.
Rockwell-Standard Corp. Brake Div., Ashtabula, Ohio
John A. Roebling's Sons Corp., Sub. Colorado Fuel & Iron Corp., 640 South Broad St., Trenton 2, N. J., Adv. p123
Rollway Bearing Co., Inc., 541 Seymour St., Syracuse 4, N.Y.
Rome Cable Corp., 330 Ridge St., Rome, N. Y., ADV. pp172-173
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Joseph T. Ryerson & Son, Inc., P. O. Box 8000A, Chicago 80, Ill.

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SKF Industries, Inc., P. O. Box 6731, Philadelphia 32, Pa., ADV. pp178-179
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The Salem Tool Co., 767 S. Ellsworth Ave., Salem, Ohio, ADV. p8
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Sauerman Bros., Inc., 620 South 28th Ave., Bellwood, Ill.
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The W. W. Sly Manufacturing Co., 4772 Train Ave., Cleveland 1, Ohio
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The Youngstown Sheet and Tube Co., Youngstown 1, Ohio, ADV. pp112-113

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TENNESSEE, Memphis: Metal Goods Corp., 1970 Latham St.

AMERICAN BRATTICE CLOTH CORP.
Argonne Rd., Warsaw, Ind.

DISTRICT SALES OFFICE
OHIO, Cleveland: 1313 W. 11th St.

AMERICAN BRAKE SHOE CO., AMERICAN MANGANESE STEEL DIV.
389 E. 14th St., Chicago Heights, Ill.

AMERICAN CYANAMID CO.
Bound Brook, N. J.
ALABAMA, Bessemer
COLORADO, Denver: 1455 Kearney St.
MISSOURI, St. Louis: 5025 Pattison Ave.
PENNSYLVANIA, Latrobe: P.O. Box 270
Pottsville: 209 North 19th St.
Scranton
TEXAS, El Paso: 3001 Memphis St.
UTAH, Salt Lake City
WEST VIRGINIA, Bluefield
WASHINGTON, Spokane: West 242 Riverside Ave.

AMERICAN MINE DOOR CO.
2057 Dueber Ave. S.W. Canton 6, Ohio, Glendale 4-7055

DISTRIBUTORS
ALABAMA, Birmingham 13: J. T. Sudduth & Co., 2923 Cahaba Rd., Tremont 9-3496
COLORADO, Denver 2: Ralph R. Moore, Inc., 1921 Blake St., Cherry 4-2969
KENTUCKY, Madisonville: Robert A. Thompson, c/o Madison Hotel, Phone 812
MICHIGAN, Ishpeming: Charter Inc., 115 S. 1st St., Hudson 6-4471
PENNSYLVANIA, Hazleton: Barrett Haentjens Sales Co., 225 North Cedar St., GL 4-0837
UTAH, Salt Lake City: National Equipment Co., 101 W. 2nd S. St., Empire 3-8878

AMERICAN OIL CO.
555 Fifth Ave., New York 17, N. Y.

DISTRICT SALES OFFICES
PENNSYLVANIA, Pittsburgh: 903 Grant Bldg., Grant St.
VIRGINIA, Roanoke 6: 806 Colonial American Bank Bldg.

AMERICAN PULVERIZER CO.
1275 Maclind Ave., St. Louis 10, Mo.

DISTRIBUTORS
GEORGIA, Atlanta 3: J. B. Frescoln, 716 Walton Bldg.
ILLINOIS, Chicago 5: Mayer & Oswald Inc., 407 S. Dearborn
KENTUCKY, Louisville 1: Alfred Halliday Co., Inc., P. O. Box 756
MISSOURI, Kansas City 12: W. C. Carolan Co., 612 W. 47th St.
NORTH CAROLINA, Charlotte 9: M. Stephenson, 2842 Selwyn Ave.
NEW YORK, New York 17: Howard L. Hill, 101 Park Ave.
OHIO, Concinnati 27: W. W. Baerbalck & Associates, 7719 Reading Road, Room 2
Celeveland 18: A. Moore & Co., 3109 Mayfield Road, No. 207
PENNSYLVANIA, Cheltenham: C.V. McQuarry, Box 52
Pittsburgh 1: Titzel Engineering & Equipment Co., 260 42nd Street

AMERICAN STEEL & WIRE DIV., UNITED STATES STEEL CORP.
Rockefeller Bldg., Cleveland 13, Ohio

DISTRICT SALES OFFICES
COLORADO, Denver: 1310 First Nat. Bank Bldg., Amherst 6-3001
ILLINOIS, Chicago: 208 S. LaSalle St., Central 6-9200
MISSOURI, Kansas City: Power & Light Bldg., Grand 1-2050
St. Louis 1221 Locust St., Central 1-1277
NEW YORK, New York: 71 Broadway, Digby 4-9000
OHIO, Cincinnati: Fifth-Third Bank Bldg., Garfield 1-4460
Cleveland: Rockefeller Bldg., Tower 1-2000
PENNSYLVANIA, Philadelphia: Suburban Station Bldg., Lo 4-4000
Pittsburgh: 525 William Penn Pl., Express 1-2345

DISTRIBUTORS
ALABAMA, Fairfield: Tennessee Coal & Iron Div., U.S.S., P.O. Box 599, State 5-8011
CALIFORNIA, San Francisco: Columbia Geneva Steel Division, U.S.S., 120 Montgomery St., Sutter 1-2500
NEW YORK, New York: U.S.S. Export Co., 100 Church St., Cortlandt 7-7474

ANACONDA WIRE & CABLE CO.
25 Broadway, New York 4, N.Y.

THE ATKINSON ARMATURE WORKS
Pittsburg, Kansas: The Atkinson Armature Works, 116 E. 1st St., Adams 1-6900

ATLAS POWDER CO.
Wilmington 99, Del.

DISTRICT SALES OFFICES
ILLINOIS, Chicago: 1606 Field Bldg., 135 S. LaSalle St., Franklin 2-9530
MISSOURI, Joplin: 612 First National Bldg., Mayfair 4-924
PENNSYLVANIA, Pittsburgh: 1544 Oliver Bldg., Atlantic 1-2684
Tamaqua: 601 Schuykill Ave., Phone 1300
Wilkes-Barre: 1026 Miners Bank Bldg., Valley 3-2516
TENNESSEE, Knoxville: 813 Hamilton National Bank Bldg. Phone 2-2147
WASHINGTON, Seattle: 1320 Joseph Vance Bldg., Main 2-5110

DISTRIBUTORS
ILLINOIS, Lenaburg: Superior Explosives Co., Phone New Athens, Ill., 215
Marion: Superior Explosives Co., Mr. Ed Cash, 511 E. Main St., Phone 834
Quincy: Quincy Supply Co., 700 S. Front St. Baldwin 3-1171
INDIANA, Brazil: Hoosier Explosives Co., 26-28 S. Walnut St. Phone 2391
New Albany: C. L. Graf, Inc., 431 Pearl St., Whitehall 4-1113
KENTUCKY, Barbourville: Blair-Noonan Co.
Dorton: Dorton-Atlas Supply Co
Lothair: Speck Cornett, Phone 480
Prestonburg: Prestonburg Explosive Co., Phone 2345
OHIO, Bloomingdale: Harrison Powder Co.
Canton: Apex Powder Corp., 1545 Waynesburg Rd., S.E.
Oak Hill: Oak Hill Powder Supply Co.
PENNSYLVANIA, Brockway: Beadle Corp.
Clarion: Amos L. Dolby
Clymer: Longwill Mine Supply Co. 56 Morris St.
Hastings: James McNelis
Hopewell: F. M. Zeth Co.
Hollsopple: L. & S. Drilling
Listie: Edward Steinkirchner
Meyersdale: Shipley Hardware Co.
Philipsburg: John F. Mitchell Cold Stream
Ramey: Williams Powder Co.
Sidman: George H. Miller
Tyler: Patsy Georgino & Son
Uniontown: George F. Buerger 656 Bierer Lane
TENNESSEE, La Follette: Card Expolsives Co., Phone 85
Monterey: Monterey Hardware Co.
Pikeville: Four Way Store Gilbert 7-5710
S. Pittsburg: Paul's Food Market, Temple 7-7551
Whitewell: Marion Mine & Mill
VIRGINIA, Big Rock: Buchanan
Grundy: Bevins-Atlas Co., P. O. Box 1168
Norton: Witaker-Atlas Supply Co., Phone 8-W-3
WASHINGTON, Seattle: Carrington Co., 91 Columbia St.
WEST VIRGINIA, Beckley: West Virginia Explosives Co., Cl 2-7061
Bluefield: Bluefield Hardware Co., 400 Bluefield Ave.
Bluefield Supply Co., 100 Mercer St., Phone 6121
Enterprise Trucking Co., Davenport 7-2361
Equip. Co., Inc., 300 N. Fourth St.
Clarksburg: Atlas Supply &
Charleston: W. Virginia Explosive Co., Riverside 4-5521
Superior Sterling Co., 200 Bluefield Ave.
East Rainelle: Greenbrier Explosive Co., He 8-7171
Lewisburg: Midland Explosives & Equip. Co.
Sutton: A. L. Rose & Co.

AUSTIN-WESTERN CONSTRUCTION EQUIPMENT DIV., BALDWIN-LIMA-HAMILTON CORP.
Aurora, Illinois

DISTRIBUTORS
ALABAMA, Birmingham 1: Joe Money Machinery Co., Inc., P.O. Box 1389, 903 Third Ave., West State 8-6501
Chickasaw: May Machinery Co., Drawer R, Telegraph Road, Phone: Mobile Hemlock 3-9559
ARKANSAS, Fort Smith: R. A. Young & Son, Inc., 301 South Tenth St., Sunset 3-8901
Litte Rock: R. A. Young & Son, Inc., 5th & Rector St., Franklin 2-0172
COLORADO, Denver 16: MacDonald Equipment Co., 5300 Colorado Blvd., Amherst 6-2641
GEORGIA, Atlanta 18: R. S. Armstrong & Bro. Co., 676 Marietta St., N.W. Jackson 4-6434
ILLINOIS, Hoopeston: Cox Bros., Dixie Highway, Phone 1010
Rock Island: Midland Truck & Equipment, Inc., 2219 Third Ave., Phone 8-8235
Melrose Park: McAllister Equipment Co., 1615 N. Mannheim Rd., Filmore 5-2740

INDIANA, Indianapolis: Malotte Machinery Co., 6937 E. 42nd St., Liberty 7-5453
Petersburg: Fred Malotte Machinery Co., Inc., P.O. Box 34 Main St., Phone 98
MISSOURI, St. Louis 10: Machinery, Inc., 5081 Manchester Ave., Jefferson 5-2056
MONTANA, Butte: Hall-Perry Machinery Co., 812 E. Iron St., Phone 2-2323
NORTH CAROLINA, Charlotte 1: H. B. Owsley & Son, Inc., P.O. Box 449, U.S. Highway 21 S., Franklin 6-8444
NORTH DAKOTA, Fargo: Northwestern Equipment, Inc, 2800 West Main St., Adams 5-7583
Minot: Northwestern Equipment Co. of Minot, P.O. Box 152 U.S. Highway 52 West, Phone 69-111
OHIO, Cincinnati: Rish Equipment Co., Dalton Ave. at Hopkins St., Garfield 1-1240
Cleveland: Rish Equipment Co., 9255 Brookpark Rd., Shadyside 9-4200
Dayton: Rish Equipment Co., 2375 Dryden Rd., Axminister 3-4185
Portsmouth: Rish Equipment Co., North on U.S. 23, Blackburn 9-5801
Toledo: Rish Equipment Co., 101 N. Westwood Ave., Jefferson 6-3744
Youngstown: Rish Equipment Co., 250 E. Indianola Ave., Sterling 8-5041
OKLAHOMA, Enid: Bert Smith Rd. Machinery Co., Inc., P.O. Box 1266, 221 West Chestnut St. Adams 4-4950
OREGON, Portland 14: Columbia Equipment Co., 1240 S.E. 12th Ave., Belmont 2-7148
PENNSYLVANIA, Carnegie: John W .Patterson Co., P.O. Box 515, 128 Hanover St., Rook Station Browning 9-3500
Erie: J. F. Brittain, Inc., R.D. 4, Phone 999-105
Harrisburg: Stephenson Equipment Inc., Box 69-Hill Station, 4200 Chambers Hill Rd., Cedar 8-4220
Philadelphia 43, Stewart Equipment Co. of Phila., Inc., 52nd St. & Woodland Ave., Saratoga 7-1611
SOUTH DAKOTA Sioux Falls: Pecaut Equipment Co., 900 E. Eighth St., Phone 8-6048
TENNESSEE, Knoxville: Peterson Machinery of Knoxville, Inc., 3115-3117 Central Ave., N.W., Phone 5-3572
Nashville 4: Peterson Machinery Co. 309 Seventh Ave., South Phone Alpine 5-8608
TEXAS, Dallas 1: Hi-Way Machinery Co., 6312 Com.nerce St., Taylor 4-5168
UTAH, Salt Lake City 15: Western Machinery Co., Box 2548, 2300 South Main St., Inersol 6-9668
VIRGINIA Richmond 27: Capital Equipment Co., Inc., P.O. Box 9246-Bellevue Station, 2050 Westmoreland St., Phone 5-1789
WASHINGTON, Seattle: Columbia Equipment Co., 5030 First Ave., South Lander 1530
Spokanne: Columbia Equipment Co., North 1007 Freya St., Keystone 4-1581
WEST VIRGINIA, Huntington 3: Porter Supply Co., Inc., P.O. Box 736, 1703 Seventh Ave. Phone 2-6651
WYOMING, Cheyenne: Keremi Tractor & Equipment Co., 702 W. Seventeenth St., Phone 8-3923

AUTOCAR DIV., THE WHITE MOTOR CO.
Exton, Pa.

DISTRICT SALES OFFICES

ALABAMA, Birmingham 3: 1701 3rd Ave., South, Fairfax 3-6301
CALIFORNIA, Los Angeles 15: 400 E. Washington Blvd., Richmond 9-9171
San Francisco 7: 500 Brannan St. YU 2-5134
COLORADO, Denver 5: 1910 38th St., Acoma 2-4661
GEORGIA, Atlanta 7: 70 Boulevard N.E. Jackson 2-8242
ILLINOIS: Chicago 16: 2401 Archer Ave., Victory 2-8180
Chicago Northside: 6421 W. Fullerton Ave., Merrimac 7-5716
INDIANA, Indianapolis 2: 1400 N. Senate Ave., Melrose 4-8427
KENTUCKY, Louisville 2: 804 S. 5th St. Juniper 4-2243
LOUISIANA, New Orleans 13: S. Claiborne at Earhart Blvd., Box 13261 Broadmore Station, Tulane 4665
MARYLAND, Baltimore 18: 708-728 E. 25th St., Belmont 5-5400
MASSACHUSETTS, Boston 15: 930 Commonwealth Ave., Aspinwall 7-5300
MICHIGAN, Detroit 16: 2950 12th St., Temple 2-7600
MINNESOTA, Minneapolis 14: 2812 University Ave., S.E. Federal 9-8101
MISSOURI, Kansas City 6: 522 Locust St., Trafficway, Grand 1-0014
St. Louis 6: 1415 N. 13th St. Garfield 1-6181
NEBRASKA, Omaha 2: 20th and Leavenworth St., Harney 0242
NEW JERSEY, Newark 5: 190 Murray St., Bigelow 2-4400
NEW YORK, Albany 4: 460 N. Pearl St., Phone 5-1447
Buffalo 4: 85 Michigan Ave., Mohawk 4225
New York 17: 415 Madison Ave., Eldorado 5-0800
New York 36: 547 W. 47th St., Circle 5-5511
NORTH CAROLINA ,Charlotte 8: 1514 W. Morehead St., Edison 2-4155
OHIO, Akron 6: 1250 Triplett Blvd., Princeton 3-5121
Cincinnati 6: 2230 Gilbert Ave., Woodburn 1-6005
Cleveland 1: 1421 E. 49th St., Box 5816, Endicott 1850
OKLAHOMA, Oklahoma City: 1001 S. W. 3rd St., Forrest 5-3301
OREGON, Portland 10: 2705 N.W. Nicolai St., Capitol 6-2411
PENNSYLVANIA, Philadelphia 32: 34th and Indiana Ave., Baldwin 8-6000
Pittsburgh 23: 1136 Western Ave., Fairfax 2-0400
TEXAS, Dallas 1: 2000 S. Ervay St., Hamilton 8-4646
Fort Worth 1: 825 W. Vickery Blvd., Edison 6-5507
Houston 1: 4720 Gulf Freeway, Walnut 3-5503
WISCONSIN, Milwaukee 3: 2440 W. Clybourn St., West 3-7200

DISTRIBUTORS

ARIZONA, Phoenix: Truck Equipment Co. of Arizona, 2401 W. McDowell Rd.
CALIFORNIA, Berkeley 10: West Coast Engine & Equipment Co., 1081 Eastshore Highway
INDIANA, Indianapolis 26: Flesch-Miller Tractor Co., 4611 Franklin Rd.
MICHIGAN, Hancock: White-Autocar Distributors, Inc.
MISSOURI, St. Louis: Ryan Equipment Co., 3550 Morganford Rd.
OREGON, Medford: Haupert Tractor Co. 3610 North Pacific Highway, P. O. Box 992
UTAH, Salt Lake City: Lindner & Wood White Motor Sales 712 S. Second West

AUTOMATIC VULCANIZERS CORP.
16 Hudson St., New York 13, N.Y.

B

BARBER-GREENE CO.
400 North Highland Ave., Aurora, Ill.

DISTRICT SALES OFFICES

ALABAMA, Birmingham: 512 N. 18th St.
CALIFORNIA, San Mateo: 2191 South El Camino Real
Whittier: 1402 West Hadley St.
FLORIDA, Orlando: 711 Magnolia Ave.
ILLINOIS, Chicago 6: 9 S. Clinton St.
MASSACHUSETTS, Needham Heights 94: 57 Crawford St., P.O. Box 105
MINNESOTA, Minneapolis: 5805 Lyndale Ave., South
NEW YORK, New York 17: 441 Lexington Ave.
Syracuse 2: 218 Harrison St.
TEXAS, Dallas 6: 4515 Prentice St.

BETHLEHEM STEEL COMPANY
Bethlehem, Pa.

DISTRICT SALES OFFICES

GEORGIA, Atlanta 1: J. E. McQueen 1312 Fulton National Bank Bldg. 55 Marietta St.
ILLINOIS, Chicago 1: E. H. Gumbart, 2700 Prudential Bldg. Prudential Plaza
Herrin: Hugh S. Dawson, 500 W. Monroe St.
MARYLAND, Baltimore 3: S. C. Husted, 1600 Commercial Credit Bldg., 300 St. Paul Place
OHIO, Cincinnati 2: O. W. Buenting, 1401 Fifth Third Bank Bldg., 4th & Walnut Sts.
Cleveland 13: C. W. Ganzel, 2700 Terminal Tower, 50 Public Square
PENNSYLVANIA, Johnstown: L. M. Donnelly, Res. Repr., Bethlehem Bldg., 119 Walnut St.
Philadelphia 3: R. S. Taylor 1058 Suburban Sta Bldg., 1617 Penna. Blvd.
Pittsburgh 22: R. T. Eaton, 1200 Oliver Bldg., Mellon Square
TENNESSEE, Knoxville: J. Watkins, Jr., Box 1229
UTAH, Salt Lake City 11: L. B. Gillette, Executive Bldg., 455 E. 4th South
WEST VIRGINIA, Bluefield: E. W. Outten, 2415 Bland Rd.
Charleston: L. C. Scheifly, One Morris Apts., 1 Morris St.
Charleston: L. R. Schoffstall, 909 Chappel Rd, S.E.

BIRD MACHINE CO.
South Walpole Mass., Montrose 8-0400

DISTRICT SALES OFFICES

GEORGIA, Atlanta 9: 1430 West Peachtree St., N. W.
ILLINOIS, Evanston: 603 Main St.

BIXBY-ZIMMER ENGINEERING CO.
159 Abingdon St., Galesburg, Ill.

BOSTON WOVEN HOSE & RUBBER CO., DIVISION OF AMERICAN BILTRITE RUBBER CO., INC.
P.O. Box 1071, Boston 3, Mass.

DISTRICT SALES OFFICES

ALABAMA, Birmingham: P.O. Box 1816, Tremont 9-9644
COLORADO, Denver : 710 West Colfax Ave., Alpine 5-3756
GEORGIA, Decatur: 2508 Woods Drive, BU 9-2516
ILLINOIS, Broadview: 2651 Gardner Rd., Fillmore 5-0320
KENTUCKY, Louisville 17: P.O. Box 32, Shelby Station, Highland 3118
MINNESOTA, Minneapolis 2: 1002 Baker Bldg., Federal 9-5893
MISSOURI, Kansas City 5: Room 926, 20 West 9th St. Bldg., Victor 2-8427
St. Louis 9: 2351 Lawn Ave., FI 1-8977
NEW YORK, New York 7: 30 Church St., Cortland 7-4016
OHIO, Cleveland 30: 7586 Webster Rd., Berea 4-3078

DISTRIBUTORS

ALABAMA, Birmingham: Dixon Supply Co., 2104 4th Ave., South
Decatur: H & H Supply Co., 158 First Ave.
COLORADO, Denver: Midwest Rubber & Supply Co., 710 West Colfax Ave.
ILLINOIS, LaGrange Park: Gooding Rubber Co., 806 E. 31st St.
INDIANA, Evansville: Housh Industrial Supplies, 30 Main St.
Indianapolis: W. J. Holliday Co.
Richmond: Queen City Supply Co.
KENTUCKY, Lexington: Industrial Division, Womwell Automotive Parts Co., Inc. 240 Clark St.
Louisville: Henderson Rubber Co., 1010 Clarks Lane
OHIO, Cincinnati 27: Queen City Supply Co., 7676 Rienhold Drive
PENNSYLVANIA, Pittsburgh: Boston Woven Hose & Rubber Co. of Pittsburgh, Box 595, Fort Pitt Blvd.
TENNESSEE, Chattanooga: Rogers-Bailey Supply Co., 1146 Market St.
Knoxville: Browning Belting & Supply Co., Inc. 205 North Central
UTAH, Salt Lake City 10: Mountain States Rubber Co., 131 Social Hall Ave.
WEST VIRGINIA, Bluefield: Bluefield Supply Co.

BOWDIL CO., THE
Boylan Ave. S.E., Canton 7, Ohio, Glendale 6-7176

DISTRICT SALES OFFICES

COLORADO, Denver: Wm. Radcliff, 761 Steele St., EA 2-7151
ILLINOIS, West Frankfort: Randal A. Leach, 1004 E. St. Louis St., Phone 675
KENTUCKY, Whitesburg: A. J. Leach, Sand Lick Rd. Phone 2232
NEW MEXICO, Carlsbad: Bit Grinding Service, East Orchard Lane
OHIO, Magnolia: C. W. Weis-Burn, UN 6-2166
PENNSYLVANIA, Perryopolis: J. M. Blasco, North Liberty Ave., Redfield 6-2575
WEST VIRGINIA, Danville: E. D. Caudill, Box 132, Phone 810
UTAH, Helper: V. L. Walkington, Phone 144
CANADA, Drumheller, Alberta: Western Distributors Co.

BRODERICK & BASCOM ROPE CO.
4203 Union Blvd., St. Louis 15, Mo.

BUCYRUS-ERIE CO.
South Milwaukee, Wisconsin, Phone (Milwaukee) South 2-0900

DISTRICT SALES OFFICES

CALIFORNIA, Los Angeles 14: 308 Security Title Insurance Bldg 530 West Sixth St., Madison 4-9642
San Francisco, South: 120 Freeway St. Plaza 5-7436
GEORGIA, Atlanta 3: 1508 William-Oliver Building, Jackson 3-8446
ILLINOIS, Chicago 3: 3100 Bankers Bldg., 105 West Adams St., Franklin 2-5321
MISSOURI, Kansas City 12: 424 Nichols Road, Room 201, Valentine 1-6281
NEW YORK 20, New York: Suite 5050 30 Rockefeller Plaza, Columbus 5-4830
PENNSYLVANIA, Pittsburgh 22: 2 Gateway Center, Room 958, Atlantic 1-4815
WASHINGTON, Seattle 1: 447 White Henry Stuart Bldg., Main 2-6424
CANADA, ONTARIO, Toronto 9: Bucyrus Erie Co. of Canada Ltd., 2489 Bloor St., West Roger 6-8161

DISTRIBUTORS

ALABAMA, Birmingham 1: Tractor & Equip. Co., Inc. 4401 First Ave., North, Wo 1-4621
ARKANSAS Little Rock: Euclid-Arkansas Inc., 711 Parker St., (P.O. Box 2257), Franklin 4-4841
COLORADO, Denver 2: The Colorado Builders' Supply Co. (Equipment Div.) 1534 Blake St. West 5-3571
ILLINOIS Bellwood: D D. Kennedy, Inc., Mannhein Rd. at Madison St. (P.O. Box 177), Linden 4-5600
Rockford: D. D. Kennedy Inc. 2605 Huffman Blvd., (P.O. Box 238), Phone: 5-8759
INDIANA, Evansville: Brandeis Mach & Supply Co., P.O. Box 27

Indianapolis 19: Power Shovel Co. 4913 Massachusetts Ave., Liberty 7-9636

KENTUCKY, Louisville 8: Brandeis Mach. & Supply Co., Brooks & Warnock Sts.
Middlesboro: Brandeis Mach. & Supply Co., P.O. Box 515
Puducah: Brandeis Mach. & Supply Co., P.O Box 906

MISSOURI, Kansas City 8: Contractors Supply, 620 East 18th St., Baltimore 1-5760
Springfield: 2675 College St., Rd. University 5-6166
St. Louis 10: Euclid Sales & Service Inc., 5231 Manchester Ave., Mission 5-3417

MONTANA, Billings: (P.O. Box 957) Great Northern Tool & Supply Co., Phone: 2-2175

OHIO, Cleveland 11: The W. T. Walsh Equip Co., 12750 Beren Rd., Clearwater 204660
Columbus 22: Lorenz Equipment Co., 847 West Rich St., P.O. Box 5908 Station D, Capitol 8-2647

OKLAHOMA, Oklahoma City: Butler Sparks Equip. Co., 1704 N.W. Sixth St. (P.O Box 675), Regent 6-5585
Tulsa: Butler-Sparks Equip Co. 202 South Lansing St., Cherry 2-9210

PENNSYLVANIA, Bradford: Beckwith Machy. Co., 361 Congress St., Phone: 3166
Clearfield: Beckwith Machy. Co., Old Town Road (P.O. Box 510), Phone: 52635
Erie: Beckwith Machy. Co., 1356 E. 12th St., Phone 4-2494
Frackville: Cleveland Bros. Equip. Co., (Rt. 122) Phone 84
Harrisburg: Cleveland Bros. Equip. Co., P.O. Box 62 (R.R 1-Route 322) Phone 4-2121
Pittsburgh 6: Beckwith Machy Co., 6550 Hamilton Ave., Montrose 1-6900
Wilkes Barre: Cleveland Bros. Equip. Co., P.O. Box 425, (Rt. 309), Valley 2-8141

TENNESSEE, Kingsport: Power Equipment Co. 1430 Island Home Ave., (P.O. Box 2311). Phone 3-1211
Knoxville: Valley Materials Handling Inc., 6012 Clinton Highway, Myrtle 1-5407
Memphis 2: Euclid-Memphis Sales Inc., 1055 Harbor Ave., (P.O. Box 2493), Whitehall 2-2421
Nashville: Euclid-Tennessee Inc., 720 Murfreesboro Road (P.O. Box 1176), Alpine 6-1648

UTAH, Salt Lake City 10: Lang Construction Equip. Co. First South & Second West (P.O. Box 1646), Davis 8-8341

WASHINGTON, Seattle 24: Northern Commercial Co., 4233 W. Marginal Way (P.O. Box 3562) Mutual 2300
Seattle 4: Clyde Equip. Co., 3410 First Avenue South, Main 2-1235
Wyoming, Casper: The Colorado Builders' Supply Co. (EQUIP-DIV.) 2100 East Yellowstone Highway

BUTTNER WORKS, INC.
52 Vanderbilt Ave., New York 17, N.Y.

C

CARRIER CONVEYOR CORP.
254-A N. Jackson St., Louisville, Ky.

CATERPILLAR TRACTOR CO.
Peoria, Illinois

DISTRICT SALES OFFICES

CALIFORNIA, San Francisco 4: 120 Montgomery St.
San Leandro

DISTRICT OF COLUMBIA, Washington 6: 200 World Center Bldg., 918 16th St., N. W.

ILLINOIS, Aurora
Decatur
Joliet

NEW YORK, New York City 20: International Bldg., Rockefeller Center, 630 5th Ave.

PENNSYLVANIA. York

WISCONSIN, Milwaukee

DISTRIBUTORS

ALABAMA, Birmingham 2: Thompson Tractor Co., Inc. 500 North 28th St., P.O. Box 2642

ARKANSAS, Fort Smith: J. A. Riggs Tractor Company, South 71 Highway at Fort Chaffee Rd. P.O. Box 507, Sunset 2-0377
Jonesboro: J. A. Riggs Tractor Company, 3227 East Nelleton Rd., P.O. Box 56, Webster 2-7469

COLORADO, Denver 17: McCoy Co., 60th and Colorado Blvd. P.O. Box 5188, Atlas 8-2621

INDIANA, Evansville: Whayne Supply Co., Highway 41, South P.O. Box 835, Harrison 4-9296
Indianapolis 18: MacAllister Machinery Co., Inc., 2118 North Gale St., Liberty 6-2471

KENTUCKY, Ashland: Whayne Supply Co., 23rd and Greenup, P.O. Box 1178, East 4-2114
Louisville 2: Whayne Supply Co., 8th and Main Sts., P. O. Box 1737, Juniper 7-6803
Paducah: Whayne Supply Co., 1600 North 8th, P.O. Box 1054, Phone 3-3631

MISSOURI, Kansas City 8: Dean-Hobson Equipment Co., Inc., 2131 Washington St., Harrison 1-6615
St. Louis 18: John Fabick Tractor Company, 3100 Gravois Ave., Prospect 2-8900

MONTANA, Billings: Nash-Davis Machinery Co., 1145 Highway 10, E. P. O. Box 2542, Phone 4-4118
Missoula: Westmont Tractor Co., 170 East Spruce St., P.O. Box 1445. Phone: 6-6666

OHIO, Cadis: Ohio Machinery Co., RD 1, U.S. Rt. 250, Phone 465
Cincinnati 13: The Highway Equipment Company, 2150 Langdon Farm Rd., Melrose 1-2767
Cleveland 9: Ohio Machinery Co., 6606 Schaaf Rd., P.O. Box 2239 Lafayette 4-2911
Columbus 16: Ohio Machinery Co., 930 Kinnear Rd., P.O. Box 149

OKLAHOMA, Oklahoma City 1: Hoover Equipment Co., 1900 Linwood Blvd., P.O. Box 988 Regent 6-3631
Tulsa 8: Albert & Harlow, Inc., 6501 East Admiral Place, P.O. Box 3126, Temple 8-3307

OREGON, Portland 10: Halton Tractor Co., 2439 N. W. 29th Ave., P.O. Box 3778, Capitol 6-3511

PENNSYLVANIA, Bradford: Beckwith Machinery Co., 361-369 Congress St., P.O. Box 369, Phone: 3166
Clearfield: Beckwith Machinery Co., Old Town Rd., P.O. Box 510, Phone: 5-9635
Erie: Beckwith Machinery Co., 1356 E. 12th St., P.O. Box 66, Phone: 4-2494
Farrell: Beckwith Machinery Co., P.O. Box 111, Phone: Farrell-(Sharon) Diamond 63572
Frackville: Cleveland Brothers Equipment Co., Inc., State Rd. Route 122, P.O. Box 68, Phones 701 and 702
Harrisburg: Cleveland Brothers Equipment Co., Inc. Route 322, P.O. Box 62, Jordan 4-2121
Philipsburg: Cleveland Brothers Equipment Co., Inc. 307 Alder St., P.O. Box 431, Dickens 2-4210
Pittsburgh 6: Beckwith Machinery Co., 6550 Hamilton Ave., East Liberty, Montrose 1-6900
Wilkes-Barre: Cleveland Brothers Equipment Co. Inc. Route 309 near Blackman St., P.O. Box 425, Valley 2-8141

TENNESSEE, Knoxville: R. L. Harris, Inc., 4302 Chapman Highway, P.O. Box 99, Phone: 7-4433
Memphis 2: Taylor Machinery Co., South Third and Carolina Sts., P.O. Box 2846 DeSoto Station Jackson 74356
Nashville 2: Thompson & Green Machinery Co., Inc., 700 Murfreesboro Rd., P. O. Box 988, Alpine 4-1661

UTAH, Salt Lake City 15: Wheeler Machinery Co., 230 West 21st South St., Hunter 7-7811

VIRGINIA, Norton: Carter Machinery Co., Inc., P.O. Box 541, Phone: 1010
Roanoke: Carter Machinery Co., Inc., 1919 Tenth St., N.W. P.O. Box 929, Empire 6-8861

WASHINGTON, Seattle 24: Northern Commercial Co., 4233 West Marginal Way, West 7-3300
Spokane 10: Byrne Machinery Co., 4625 E. Trent Rd., P.O. Box 2201, Keystone 4-0555

WYOMING, Rock Springs: Wortham Machinery Co., "E" Street and Rennie, P.O. Box 947, EM 2-3784
Sheridan: Wortham Machinery Co., 1815 North Main St., P.O. Box 728, OR 4-7419

CENTRIFUGAL & MECHANICAL INDUSTRIES, INC.
146 President St., St. Louis 18, Mo., PR 62848

DISTRICT SALES OFFICE

WEST VIRGINIA, Huntington: 925 6th Ave., Jackson 9-4131

CHEATHAM ELECTRIC SWITCHING DEVICE CO.
4780 Crittenden Dr., Louisville 9, Ky., Emerson 3-3571

SALES OFFICES

UTAH, Salt Lake City: 275 South West Temple, DA 2-4311

CHICAGO PNEUMATIC TOOL CO.
6 East 44th St., New York 17, New York

CALIFORNIA, Los Angeles 22: 6935 Bandini Blvd.
San Francisco 3: 855 Bryant St.

COLORADO, Denver 4: 465 Acoma St.

GEORGIA, Atlanta 9: 91-16th St., N.W.

ILLINOIS, Chicago 19: 936 East 87th St.

MICHIGAN Detroit 26: 570 East Larned St.

MISSOURI, St. Louis 17: 8029 Lizinger Road

PENNSYLVANIA, Pittsburgh: 369 Coltart Ave.

DISTRIBUTORS

ARKANSAS, Fort Smith: Bruce Rogers Co., 51 So. 6th St.

ILLINOIS, Chicago: Goodman Manufacturing Co., 4834 S. Halstead St.
Peoria: Dooley Bros., 1201 S. Washington St.

INDIANA, Evansville 5: Austin Powder Co., 616 N.W. 2nd St.
Terre Haute: Advance Electrical Co., 545 N. 6th St.
Terre Haute: Mine Supply Co., 417 N. 13th St.

KENTUCKY, Harlan: Kentucky Mine Supply Co.
Harlan: McComb Supply Co.
Lochair: Mine Supply Co.
Madisonville: Minton Machinery & Supply Co., 330 W. Center St.

PENNSYLVANIA, Johnston: M. Glosser & Sons, Inc., 72 Messenger St.
Johnston: Penn Machine Co.
Scranton 9: L. A. Harding Co. 1625 Nay Aug Ave.

TENNESSEE, Jellico: McComb Supply Co.

VIRGINIA, Grundy: Buchan-Williamson Supply Co.
McClure: Erwin Supply & Hardware Co.

WEST VIRGINIA, Charleston: Charleston Electrical Supply Co. 312 MacCorkle Ave.
Charleston 27: Persingers, Inc., P.O. Box 1866
Fairmont: Fairmont Supply Co., 10th & Belt Line
Huntington: Ensign Electric & Mfg. Co., 914 Adams Ave.
Wheeling: Pennsylvania & West Virginia Supply, P.O. Box 871
Williamson: Persingers Supply Co.
Williamson: Williamson Supply Co.

CINCINNATI MINE MACHINERY CO.
Cincinnati 25, Ohio

DISTRIBUTORS

ALABAMA, Birmingham: J. T. Sudduth & Co., P.O. Box 3123 Avondale Station

COLORADO, Denver: Union Supply Co., P.O. Box 6735 Stockyard Station

ILLINOIS, Benton: W. M. Hales Co., Box 303
Chicago: W. M. Hales Co., 605 W. 116th St.
Danville: W. M. Hales Co., Box 65
Hillsboro: W M. Hales Co., Box 356
West Frankfort: W. M. Hales Co., Box 239

KENTUCKY, Harlan: McComb Supply Co.
Madisonville: W. M. Hales Co., Box 91

NEW MEXICO, Carlsbad: Carlsbad Supply Co.

PENNSYLVANIA, Johnstown: Penn Machine Co., Station St.
Pittsburgh: Penn Machine Co., Union Trust Bldg.

TENNESSEE, Jellico: McComb Supply Co.

UTAH, Helper: Carbon Transfer & Supply Co., P.O. Box 180
Kenilworth: Frank Armstrong

WEST VIRGINIA, Huntington: Huntington Supply & Equipment Co., Box 370

CANADA, Alberta, Drumheller: Gorman's Ltd.
Alberta, Edmonton: Gorman's Ltd.
New Brunswick, St. John: E. S. Stephenson & Co., 15 Dock St.
Nova Scotia, Halifax: E. S. Stephenson & Co., P.O. Box 1033

AUSTRALIA, St. Leonards, New South Wales: Mole Engineering (Pty) Ltd.

CHILE, Santiago: Scoiedad Importadora del Pacifico, Ltda., Alameda 1166, Casilla 82-D

SOUTH AFRICA, Durban: F. G. Licence (Pty) Ltd., P.O. Box 1362

COLLYER INSULATED WIRE CO.
245 Roosevelt Ave., Pawtucket, R.I.

COLORADO FUEL & IRON CORP.
Wickwire Spencer Steel Division, Box 232, Palmer, Mass., Palmer 1030

DISTRICT SALES OFFICE

COLORADO Denver 2: 4950 Colorado Blvd., Dudley 8-2491
Peublo: P.O. Box 316, Li 3-2470

ILLINOIS, Chicago 32: 3838 W. 51st Street Lu 5-8000

NEW YORK, Buffalo 2: 361 Delaware Avenue, Mohawk 5600

PENNSYLVANIA, Emlenton: P.O. Box 388, Phone 201
Philadelphia 40: 225 West Erie Avenue, Garfield 5-4000

TENNESSEE, Chattanooga 10: 916 West 33rd Street, Taylor 1-7508

UTAH, Salt Lake City: 212 W. 13th Street, Ingersoll 7-5438

COMBUSTION ENGINEERING INC., RAYMOND DIV.
1315 N. Branch St., Chicago 22, Ill.

DISTRICT SALES OFFICES

NORTH CAROLINA, Charlotte 3: 518 E. Morehead St.

OHIO, Cincinnati 2: 1101 Enquirer Bldg.
Cleveland 13: 733 The Illuminating Bldg.

PENNSYLVANIA, Philadelphia 3: 1616 Walnut St.
Pittsburgh 22: 1 Gateway Center

COMPTON, INC.
P. O. Box 1946, Clarksburg, W. Va.

SALES AGENTS

KENTUCKY, London: Earl Copeland, 134 West Dixie St.

CONNELLSVILLE MFG. & MINE SUPPLY CO.
S. Fourth St., P.O. Box 677, Connellsville, Pa.

DISTRICT SALES OFFICE

ALABAMA, Birmingham 3: 2213 Sixth Ave., South

CRESCENT BELT FASTENER CO.
381 Fourth Ave., New York 16, N.Y.

CONSTRUCTION EQUIPMENT DIV. BALDWIN-LIMA-HAMILTON CORP.
S. Main St., Lima, Ohio, CA 4-0421

DISTRICT SALES OFFICES

ALABAMA, Mobile: P. O. Box 14 Plateau Sta. 849 Telegraph Rd. Hemlock 3-5477

ARKANSAS, Little Rock: P. O. Box 2197, Fifth & Rector Sts., Franklin 2-0172

CALIFORNIA, LaMirada: P. O. Box 38, 14120 E. Rosecrans Ave., Phone: Norwalk, Cal.-University 3-5761

ILLINOIS, Peoria: 3601 Farmington Road, Phone: 4-1174

INDIANA, Evansville: Boonville Road East, Gr 6-1348
Michigan City: 2503 Lake Shore Drive, Triangle 2-2598
South Bend: P. O. Box 2594 Atlantic 8-1491

NEW YORK, New York 3: 111 Fifth Ave., Oregon 7-5030

OHIO, Dayton 39: 3159 Encrete Road Axminister 8-5217
Toledo 6: 3038 Reynolds Rd. Jefferson 1465

OKLAHOMA, Oklahoma City: 21-15 Exchange Avenue, Regent 9-1558
Tulsa: P. O. Box 8008, Dawson Station, 9401 East Admiral Place, Temple 5-4404

TEXAS, Dallas 7: 2356 Irving Blvd., Riverside 1-4719

WASHINGTON, Seattle 4: 1932 First Avenue South, Main 4-5420

DISTRIBUTORS

ALABAMA, Birmingham 6: G. C. Phillips Tractor Co., Inc., P. O. Box 2897, Woodlawn Station, 4419 First Avenue, N., Worth 1-4605

ARKANSAS, Fort Smith: R. A. Young & Son, Inc., 301 South Tenth St., Sunset 3-8901

COLORADO, Denver 16: Faris-Moritz Equipment Co., 5790 Colorado Blvd., Atlas 8-2684

INDIANA, Indianapolis 21: Reid-Holcomb Company, Inc., 1815 Kentucky Avenue, Melrose 2-4433

KENTUCKY, Louisville 13: Rudd Construction Equipment Co., Inc., 4344 Poplar Level Rd., Glendale 2-2606

MISSOURI, Kansas City 8: Machinery & Supplies Co., Inc. 2000 Walnut St., Victor 2-5457
St. Louis 10: Machinery Inc., 5081 Manchester Avenue, Jefferson 5-2056

NORTH CAROLINA, Winston-Salem: J. W. Burress, Inc., 738 E. 28 St., Park 3-5544, Park 4-0251
Cleveland 30: Cleveland Contractors Equip. Co., 1904 Brookpark Road, Shadyside 1-5570.
Columbus 7: Columbus Equipment Co., 50 East Kingston Ave., Hickory 3-6541

OHIO, Cincinnati 42: Carroll & Edwards Co., Deerfield at E. Kemper Rd., Tweek 1-4300

PENNSYLVANIA, DuBois: Highway Equipment Co., 40 Hoover Ave., Phone: 4091
Harrisburg: Highway Equipment & Supply Co. 5100 Paxton St., Jordan 4-3031
Hazleton: Frank Swabb Equipment Co., Inc., Suite 313, Hazleton National Bank Bldg., Gladstone 5-3658
Philadelphia 29: M-W Equipment Co., Hunting Park Ave. & Fox St., Baldwin 6-2600
Pittsburgh 6: Highway Equipment Co. 6465 Hamilton Ave., Emerson 1-3600

TENNESSEE, Memphis 5: Priester Machinery Co., P. O. Box 310, 249 S. Third St., Jackson 5-6885
Nashville 4: Peterson Machinery Co. 309 Seventh Ave., S., Alpine 5-8606

VIRGINIA, Roanoke: J. W. Burress, Inc., 1701 Shenandosh Ave., N. W., Diamond 3-1507

WEST VIRGINIA, Charleston: Machinery Inc., P. O. Box 2911, 2855 Piedmont Road, Walnut 5-2121
Clarksburg: West Virginia Mine Supply Co., P. O. Box 872, 212 Ohio Ave., Main 4-7491

CROSS PERFORATED METALS PLANT NATIONAL-STANDARD CO.
170 Dundaff, Carbondale, Pa. Carbondale 300

D

DAVEY COMPRESSOR CO.
600 Franklin Ave., Kent, Ohio

DISTRICT SALES OFFICES

GEORGIA, Decatur: 2812 Laurel Ridge Dr., Melrose 4-7714

NEW JERSEY, Ridgewood: 553 Hillcrest Rd., Gilbert 5-3120

OHIO, Cuyahoga Falls: 2785 Tift St., Walbridge 8-9539

DISTRIBUTORS

ALABAMA, Adamsville: Blackwell Trucking Co., P.O. Box 3, State 8-0119

BIRMINGHAM: Money Machinery Co., 903 3rd Ave., W., Telephone; 58-6501

KENTUCKY, Lexington: Contractors Equipment Co., Inc., 780 E. 3rd St., Telephone 2-1475
Louisville: Contractors Equipment Co., Inc., 4410 Poplar Level Rd., GL 8-3022

OHIO, Columbus 22: Machinery & Tool Rentals, Inc., 511 West Town St., Capital 8-6725

PENNSYLVANIA, Forty Fort: Yarrish Equipment Co., 1609 Wyoming Ave.
Frostburg: Stockdale Mine Supply Co., Punxsutawney 2182
Pittsburgh 21: Conte Equipment Co., P.O. Box 8607 Brandywine 1-4380

WEST VIRGINIA, Charleston 27: Baker Equipment Engr. Co., Inc., 404 Morris St.
Charleston Equipment Distributors, Inc., P.O. Box 4275
Vienna: Vienna Tractor & Equipment Corp., 1016 18th St.

DEISTER CONCENTRATOR CO., INC.
903 Glasgow Ave., Fort Wayne, Ind.

DISTRICT SALES OFFICES

ALABAMA, Birmingham: 2612 N. 24th St.

CALIFORNIA, Los Angeles: 2020 Sacramento St.

NEW YORK, New York 4: 60 Beaver St.

PENNSYLVANIA, Nesquehoning: 35 E. Center St.

DIFFERENTIAL STEEL CAR CO.
Findlay, Ohio

DODGE DIVISION, CHRYSLER CORP.
7900 Jos. Campau, Detroit 31, Mich.

DOMINICK & DOMINICK
14 Wall St., New York 5, N. Y.

DORR-OLIVER INCORPORATED
77 Havemeyer Lane, Stamford, Connecticut, Fireside 8-5871

DISTRICT SALES OFFICES

CALIFORNIA Oakland 1: 2900 Glascock St., Kellogg 3-3636

COLORADO, Englewood (Denver): 2916 S. Fox St., Sunset 1-6635

GEORGIA, Atlanta 9: 900 Peachtree St., N.E., Trinity 5-8151

ILLINOIS, Chicago 54: 813 Merchandise Mart. Delaware 7-0723

MARYLAND Baltimore 18: 2128 Maryland Ave., Hopkins 7-2041

MINNESOTA, Virginia: 204½ Chestnut Ave., Sherwood 1-4689

OHIO, Cleveland 7: 14700 Detroit Ave., Academy 1-4320

PENNSYLVANIA, Pittsburgh 27: 4209 Clairton Blvd., Tuxedo 4-1732

DRAVO CORP.
Neville Island, Pittsburgh 25, Pa.

DU PONT DE NEMOURS & CO., E.I., ELASTOMER CHEMICALS DEPT.
Wilmington 98, Del.

DURAKOOL, INC.
Elkhart, Ind.

DISTRICT SALES OFFICES

MINNESOTA, Minneapolis: 301 Fifth Ave., S.

NEW YORK, New York 70: 4747 Bronx Blvd.

CANADA, Toronto, Ontario: 1969 Avenue Rd.

E

ENSIGN ELECTRIC & MANUFACTURING CO.
914 Adams St., Huntington 8: West Virginia

DISTRICT SALES OFFICES

ILLINOIS, Chicago: 309-222 South Michigan Ave., J. A. Schonthal & Associates, Wabash 2-8350

DISTRIBUTORS

ALABAMA, Birmingham 5: 429 South 24th St., J. L. Thomas, Fa 4-7032

PENNSYLVANIA, McKees Rocks (Pittsburgh): Nichol Ave., P.O. Box 72, Schroeder Brothers Corp., Spalding 1-4810

ENTERPRISE WHEEL & CAR CORP.
Bristol, Va.

DISTRICT SALES OFFICES

WEST VIRGINIA, Huntington: Camden Rd., Hamilton 9-1349
Bluefield: P. O. Box 182, Davenport 7-6640

EXIDE INDUSTRIAL DIV., ELECTRIC STORAGE BATTERY CO.
42 S. 15th St., Philadelphia 2, Pa.

DISTRICT SALES OFFICES

ALABAMA, Birmingham 9: 1925 29th Ave. S., Tremont 9-5321

COLORADO, Denver 2: 234 Commonwealth Bldg., Main 3-7793

DISTRICT OF COLUMBIA, Washington 16: 4000 Albemarle St., N.W. Emerson 2-6800

GEORGIA, Atlanta 10: 1246 Allene Ave. S. W., Plaza 8-2621

ILLINOIS, Chicago 9: 5335 S. Western Blvd., Walbrook 5-9-800.
Peoria: 423 1st Nat'l Bank Bldg., Phone 4-5051

INDIANA, Indianapolis 4: 325 Bankers Trust Bldg., Melrose 5-6727

MISSOURI, Kansas City 23: 129 S. Belmont Blvd., Benton 1-6300
St. Louis 8: 3928 Lindell Blvd., Olive 2-1310

NEW YORK, New York 36: 25 W. 43rd St., Bryant 9-8100

NORTH CAROLINA, Charlotte 2: 519 E. Trade St. Franklin 5-7966

OHIO, Cincinnati: Rm. 426, 307 E. 4th St., Main 1435
Cleveland 14: Cherry 1-6231

OREGON, Portland 5: 1224 S.W. Morrison St., Capital 2-3778

PENNSYLVANIA, Kingston: 33 Poplar St., Butler 7-8294
Philadelphia 4: 101 N. 33d St. Evergreen 2-5858
Pittsburgh 16: 1608 Potomac Ave., Fieldbrook 1-2832

TENNESSEE, Memphis: 902 Dermon Bldg., Jackson 6-5842

TEXAS, Dallas 1: 2133 McKinney Ave., Riverside 1-9977

UTAH, Salt Lake City 7: P.O. Box 133, Murray Branch, Elgin 9-5766

WASHINGTON, Seattle 1: 500 Wall St., Main 3-1377.
Spokane 1: 617 Paulsen Bldg., Madison 4-1295

WEST VIRGINIA, Charleston: P. O. Box 1562, Dickens 6-8201

F

FAIRBANKS, MORSE & CO.
600 South Michigan Ave., Chicago 5, Illinois

DISTRICT SALES OFFICES

ILLINOIS, Chicago 5: 1550 South State St., Harrison 7-7100

OHIO, Cincinnati 37: 4815 Para Drive, Jefferson 1-8860
Cleveland 11: 3000 West 117th St., Clearwater 1-3300

NEW JERSEY, Fairlawn: 19-01 Route 208, Swarthmore 6-2100

MISSOURI, St. Louis 2: 217 South Eighth, Main 1-3130

FAIRMONT MACHINERY CO.
Fairmont, W. Va., Fairmont 1672

THE FALK CORP.
Milwaukee 1, Wisconsin

DISTRICT SALES OFFICES

ALABAMA, Birmingham 3: Brown-Marx Bldg., Room 649, Fairfax 4-1433

ILLINOIS, Chicago 3: 105 W. Adams St., State 2-6686
Peoria: 800 S. W. Adams St., Phone 6-0433

INDIANA, Indianapolis 5: 2132 E. 52nd St., Clifford 5-5434

MARYLAND, Baltimore 12: 4231 Greenmount Avenue, Tuxedo 9-4969

MISSOURI, St. Louis 5: 8029 Forsyth Blvd., Parkview 5-8300
Kansas City 8: (B. L. McCreary & Son) 1819 Central St., Harrison1-1668

NEW JERSEY, Newark 2: 100 Parkhurst St., Bigelow 2-5300

OHIO, Akron 9: (B. W. Rogers Co.,) P. O. Box 1030, Portage 2-0251
Cincinnati 2: 609 American Bldg., Main 1-2364
Cleveland 15: Room 215, 2036 E. 22nd St., Main 1-0074
Columbus 12: 1504 W. 1st Ave., Hudson 8-0531

PENNSYLVANIA, Pittsburgh 19: 300 Mt. Lebanon Blvd., Suite 200B, Locust 3-1754
Wynnewood: P.O. Box 312, Midway 9-3335

TENNESSEE, Knoxville 17: (Bowditch & Co.), 1311-C Broadway, N.E., Phone 4-2513

VIRGINIA, Richmond 19: (Williamson & Wilmer), 617 Mutual Bldg., Milton 3-9003

WEST VIRGINIA, Charleston 2: P.O. Box 10066, Riverside 4-1821

FARRELL-CHEEK STEEL COMPANY
Sandusky, Ohio, Main 5-2340

SALES AGENTS

ALABAMA, Birmingham: Ebbert & Kirkman Co., Inc., 2313 6th Ave., South Alpine 1-9174

FLORIDA Tampa 3: Minich-Du-Von Corp., 2509 West Hillsboro Ave., P.O. Box No. 7292, Redwood 6-0749 & Redwood 7-1983

ILLINOIS, Chicago 40: Mr. Laurence J. White, Uptown Bank Bldg., Long Beach 1-6655

MASSACHUSETTS, Newton Lower Falls: Ward Weller Co., Inc. 2276 Washington St.

MICHIGAN, Detroit 26: Mr. John W. Taylor, 409 Griswold St.—Rm. 409, Woodward 3-2578

MINNESOTA, White Bear Lake 10: John M. Shank Co., 5 Birchwood Ave., Garden 6-2202

MISSOURI, St. Louis 18: Medart Engineering & Equipment Co., Inc., 100 Potomac St.

NEW JERSEY, Hoboken: Mr. J. J. Murray, Hudson County National Bank, 96 River St., P.O. Box 150-MO, Oldfield 9-1241

NEW YORK Rochester 2: Stamprese Engineering Co., 468 Monroe Ave., P.O. Box 545, Greenfield 3-5423

OHIO, Springfield: Mr. Mel Conwell, 109 Bellevue Ave., Fairfax 3-6120

PENNSYLVANIA, Philadelphia 32: Mr. Henry A. Smith 2727 N. 15th St., Baldwin 8-1420
Pittsburgh 22: Mr. Geo. C. Hutchinson Jr., 800 Keenan Bldg, Atlantic 1-5860

TENNESSEE, Memphis 11: Mr. Hunley A. Slaughter, Box 6403, East Station, 185 Alexander St., Glendale 2-4278

TEXAS, Dallas 5: R. C. Brown Co., P.O. Box 8026, Emerson 8-2866
Houston: 1220 Polk St., Capitol 7-2354

FEDERAL-MOGUL SERVICE DIV., FEDERAL-MOGUL-BOWER BEARINGS, INC.

11031 Shoemaker Ave., Detroit 13, Michigan

DISTRICT SALES OFFICES

GEORGIA, Atlanta 8: 24 Linden Ave., N.W., Trinity 2-3532

ILLINOIS, Chicago 16: 1923 So. Calumet Ave., Victory 2-2488

INDIANA, Indianapolis 4: 601 N. Captial Ave., Melrose 7-5541

MISSOURI, Kansas City 16: 1313 Atlantic Ave., Victor 2-1047

PENNSYLVANIA, Philadelphia 30: 1839 Wylie St., Poplar 9-2812
Pittsburgh 6: 5472 Penn Ave., Montrose 1-6664

TENNESSEE, Memphis 7A: 905 Estival Place, Jackson 5-0877

VIRGINIA, Richmond 21: 3407 W. Leigh St., Elgin 5-1751

FEMCO, INC.

Irwin, Pa.

DISTRIBUTORS

ALABAMA, Birmingham: National Mine Service Co.

KENTUCKY, Ashland: National Mine Service Co.
Jenkins: National Mine Service Co.
Madisonville: National Mine Service Co.

PENNSYLVANIA, Forty Fort: National Mine Service Co.
Indiana: National Mine Service Co.
Pittsburgh: National Mine Service Co., 564 Alcoa Bldg.

UTAH, Salt Lake City: Industrial Physics & Electronics Co.

WEST VIRGINIA, Beckley: National Mine Service Co.
Logan: National Mine Service Co.
Morgantown: National Mine Service Co., 564 Alcoa Bldg.

FLOOD CITY BRASS & ELECTRIC CO.

Messenger & Elder Sts. Johnstown, Pa. Phone 7-8919

SALES AGENTS

ALABAMA, Birmingham 1: Salmon & Co., Inc., P. O. Box 2388

WEST VIRGINIA, Montgomery: Marathon Coal Bit Co., Inc. P.O. Box 391, HI 2-2478

G

GALIS ELECTRIC & MACHINE CO.

Morgantown, W. Va., Phone 4068

GENERAL ELECTRIC CO., APPARATUS SALES DIVISION

1 River Rd., Schenectady, N.Y.

DISTRICT SALES HEADQUARTERS

CALIFORNIA, Los Angeles: 212 N. Vignes St., MA 5-7381
San Francisco 6: 235 Montgomery St., DO 2-3740

COLORADO, Denver: 650 17th St., KE 4-7171

FLORIDA, Atlanta N.W.: 1860 Peachtree Rd. TR 6-2451

ILLINOIS, Chicago 80: 840 S. Canal St., WA 2-5611

MASSACHUSETTS, Boston 1: 14 Federal St., HU 2-1800

MICHIGAN, Detroit 2: 700 Antoinette St., TR 2-2600

MISSOURI, St. Louis 1: 818 Olive St., GE 6-4343

NEW YORK, New York 22: 570 Lexington Ave., PL 1-1311
Syracuse 6: 3532 James St., HO 3-8511

NORTH CAROLINA, Charlotte 1: 112 S. Tryon St., FR 5-5571

OHIO, Cleveland 4: 4966 Woodland Ave., EN 1-4464

PENNSYLVANIA, Philadelphia 2: 3 Penn Center Plaza, LO 8-1800
Pittsburgh 22: Oliver Bldg., AT 1-6400

TEXAS, Dallas: 8101 Stemmons Freeway, FL 7-4581

WASHINGTON, Seattle 4: 710 Second Ave., MA 4-8300

GENERAL EQUIPMENT & MFG. CO.

116-120 So. Campbell St., Louisville 6, Ky.

GOODMAN MANUFACTURING CO.

Halsted St. & 48th Place, Chicago 9, Illinois

DISTRICT SALES OFFICES

ALABAMA, Birmingham 4: 812 Fifth Avenue, Fairfax 3-3222

ILLINOIS, West Frankfort, 306 W. Main St.

KENTUCKY, Harlan, P.O. Box 799, Phone 416

PENNSYLVANIA, Pittsburgh 33: 1714 Liverpool St., Cedar 1-1356
Wilkes-Barre: 25 New Bennett St., Valley 3-3013

WEST VIRGINIA, Huntington 16: 831 Second Ave., Jackson 5-9189

SALES AGENTS

AUSTRALIA: John Carruthers & Co., Pty. Sydney

BRAZIL: Formac, S. A., Rio de Janeiro

CANADA: Wing Equipment, Ltd. Vancouver, B. C.

ENGLAND: Distington Engineering Co., Ltd. Workington, Cumberland

FRANCE: S. E. T. I. S., Paris 9

INDIA: Blackwood Hodge, Ltd., Calcutta

JAPAN: C. T. Takahashi & Co., Tokyo

TURKEY: A.F.E.B.E., Istanbul

UNION OF SOUTH AFRICA: Johannesburg
Hubert Davies & Co., Ltd.,

THE B. F. GOODRICH INDUSTRIAL PRODUCTS

500 So. Main St., Akron 18, Ohio, Blackstone 3-1171

DISTRICT SALES OFFICES

CALIFORNIA, Los Angeles 22: 3725 S. Garfield Ave.,
Los Angeles 54: Box 2002 Terminal Annex
San Francisco 24: 1950 Army St.

COLORADO, Denver 4: 2500 W. Eighth Ave.,
Denver 1: P.O. Box 417

GEORGIA, Atlanta 6: 1721 DeKalb Ave., N.E
Atlanta 2: Box 4509

ILLINOIS, Chicago 44: 4646 West Lake St.

KANSAS, Kansas City 15: 830 Kindelberger Rd.

MASSACHUSETTS, Needham Heights 94: 100 Second Ave., P.O. Box 106

MICHIGAN, Aleen Par: 16500 Oakwood Blvd.

MINNESOTA, Minneapolis 16: 800 Turners Crossroad

NEW YORK, New York 17: 230 Park Ave.

OHIO, Akron 18: 500 S. Main St.
Columbus 14: 3770 Indianola Ave. P.O. Box 3507

PENNSYLVANIA, Philadelphia 34: 9?5 E. Erie Ave.

TEXAS, Dallas 2: 1400 Turtle Creek Blvd. P.O. 6185

GOODRICH TIRE CO., B.F., A DIV. OF B.F. GOODRICH CO.

Akron 18, Ohio

THE GORMAN-RUPP CO.

Mansfield, Ohio

DISTRIBUTORS

ALABAMA, Birmingham: General Mach. Co.
Birmingham: Mill & Mine Supply Co.

FLORIDA, West Palm Beach: J. P. Carroll

ILLINOIS, Christopher: Hoe Supply Co.
Mt. Vernon: Central Mines Supply Co.

INDIANA, Fort Wayne: Johns Equipment Co.

KENTUCKY, Greenville: Greenville Supply Co.
Harlan: McComb Supply Co.
Lothair: Mine Service Co.
Madisonville: Central Supply Co.

MISSISSIPPI, Jackson: Wholesale Supply Co.

OHIO, Cambridge: Cambridge Machine & Supply Co.
Jackson: Jackson Implement Co.
Lisbon: Lisbon Diesel & Supply Co.
New Philadelphia: Buckeye Machine & Supply Co.

PENNSYLVANIA, Pittsburgh: Weinmann Pump & Supply Co.
Scranton: The Bittenbender Co.

RHODE ISLAND, Ashway, Aetna Engineering

TENNESSEE, Chattanooga: Mill &Supply Co.
Knoxville: Superior-Sterling Co.
Nashville: Mid-Tenn Supply Co.

WEST VIRGINIA, Bluefield, Bluefield Supply Co.
Bluefield: Rish Equipment Co.
Clarksburg: Rish Equip. Co.
Charleston: Rish Equip. Co.
Huntington: West Virginia Pump & Supply Co.
Logan: Guyan Machinery Co.

GUNDLACH MACHINE CO., T. J., DIV. OF J. M. INDUSTRIES

226 Centreville Ave., Belleville, Ill., Adams 3-7208

SALES AGENTS

COLORADO, Denver: Clyde E. Clarkson, 4831 E. Harvard Lane, Skyline 6-5277

ILLINOS, Chicago: Schonthal & Associates, Suite 309, 224 S. Michigan Ave., Wabash 2-8350

PENNSYLVANIA, Greensburg: Andrew M. Gardner, 626 Park Lane, Phone 3350
Philadelphia: A. R. Amos Co., 713 Commercial Trust Building, Rittenhouse 6-3675

WEST VIRGINIA, Huntington 1: Marshall Equipment Co., Box 1367, Phone 3-8691
Wheeling: Richard M. Wilson, 27 Oak Park, Woodale 586

GUYAN MACHINERY CO.

755 Stratton, Logan, W. Va.

H

H & L TOOTH CO.

1540 South Greenwood Avenue, Montebello, Calif.

DISTRIBUTORS

ALABAMA, Birmingham: Leary & Owens Machinery Co., 3600 5th Ave. N.
Montgomery: Leary & Owens Machinery Co., 3165 Mobile Rd.

COLORADO, Denver: Air Rentals, Inc., 3301 Walnut St.

ILLINOIS, Salem: John Fabick Tractor Co.
Marion: John Fabick Tractor Co.

INDIANA, Evansville: Reid-Holcomb Co., Inc., Boonville Rd. East
Indianapolis: Reid-Holcomb Co., Inc., 1815 Kentucky Ave.
South Bend: Reid-Holcomb Co., Inc., West Ireland Street

KENTUCKY, Louisville: Williams Tractor Co., 3800 Crittenden Dr.
Paducah: Williams Tractor Co., 8th & Burnett Sts.

MISSOURI, Kansas City: Buchanan Equipment Co., 2645 Southwest Blvd.
St. Louis: J. Fabick Tractor Co. 3100 Gravois Ave.
Sikeston: J. Fabick Tractor Co.

OHIO, Cincinnati: Carroll & Edwards Co., Richmond & McLean Sts.
Cleveland: W. T. Walsh Equipment Co., 12750 Berea Road
Columbus: Capitol Road Machinery Co., 945 West 3rd Ave.

PENNSYLVANIA, Harrisburg: Furnival Machinery Co., 5105 Paxton Street
Pittsburgh: Parkway Machinery Co., 635 Ridge Avenue

TENNESSEE, Chattanooga: Power Equipment Co., 1080 Duncan Ave.
Memphis: Tri-State Equipment Co., 520 Mulberry Ave.
Nashville: Power Equipment Co., 800 6th Ave. N.

UTAH, Salt Lake City: Heiner Equipment Co., 50 W. 7th South

VIRGINIA, Roanoke: J. W. Burress, 1701 Shenandoah Ave., N.W.

WEST VIRGINIA, Charlestown: West Virginia Tractor & Equipment Co.
Clarksburg: West Virginia Tractor & Equipment Co., 100 Wood St.

HARNISCHFEGER CORP., CONSTRUCTION & MINING DIV.

4400 National Ave., Milwaukee 14, Wisc.

HAUSER-STANDER TANK CO.

Cincinnati 32, Ohio

HENDRICK MANUFACTURING CO.

Carbondale, Pa.

DISTRICT SALES OFFICES

NEW YORK, New York 7: 30 Church St.

PENNSYLVANIA, Hazelton: Box 315
Pittsburgh 8: 6802 Frankstown Ave.

SALES AGENTS

MISSOURI, St. Louis: Crandall Ricker Sales Corp., 1169 Paul Brown Bldg.

ILLINOIS, Chicago 4: Warren F. Kendrick, 224 S. Michigan Ave.

PENNSYLVANIA, Philadelphia: The Benson, Suite 112-C Washington Lane & Township Line, Jenkintown, Pa.
Pittsburgh 8: Buckley Associates, 6802 Frankstown Ave.

OHIO, Cleveland 21: Arthur C. Baker, 4062 Mayfield Rd.

WEST VIRGINIA, Huntington: J. Y. Smythe 832 11th Ave.,

HERCULES POWDER CO.

900 Market St., Wilmington 99, Delaware, Olympia 8-7211

DISTRICT SALES OFFICES

ALABAMA, Birmingham 3: First National Building, 17 N. 20th St., Alpine 2-0293

CALIFORNIA, Los Angeles 5: 3460 Wilshire Blvd., Dunkirk 7-8151
San Francisco 4: 120 Montgomery St., Yukon 6-2535

ILLINOIS, Chicago 4: McCormick Bldg., 332 S. Michigan Ave., Harrison 7-5230

MINNESOTA, Duluth 2: Torrey Bldg., 314-16 W. Superior St., Randolph 2-3335

MISSOURI, Joplin: First National Bank Bldg., 404 Main St., Mayfair 4-4183

NEW YORK, New York 17, 380 Madison Ave., Oxford 70010

PENNSYLVANIA, Pittsburgh 22: 2 Gateway Circle 603 Stanwix St., Grant 16171
Hazleton: National Bank & Trust Co. Bldg., 8 West Broad St., Gladstone 4-0825

UTAH, Salt Lake City 1: Kearns Bldg., 136 S. Main St., Empire 4-5513

HEYL & PATTERSON, INC.
55 Fort Pitt Blvd., Pittsburgh 22, Pa.

DISTRIBUTORS

INDIANA, Terre Haute: Templeton-Mathews Corp., 905 Sycramore Bldg.

WEST VIRGINIA, Charleston 26: Kanawha Manufacturing Co., 1520 Dixie Street

HOYT WIRE CLOTH CO.
Abraso St., P. O. Box 1577 Lancaster, Pa., Express 4-6871

DISTRIBUTORS

VIRGINIA, McClure: Erwin Supply Co.

WEST VIRGINIA, Bluefield: Lecco Machinery & Engineering Co.

Fairmont: Fairmont Machinery Co.

Shinnston: Erwin Supply Co.

HUBER-WARCO CO.
Marion, Ohio

DISTRIBUTORS

ILLINOIS, Chicago, 29: Gil Boers Equipment Company, 7625 South Kedzie Avenue

INDIANA, Lawrence 26: Deeds Equipment Co., Inc., 8015 E. 45th St., P.O. Box 8414

Rochester: Deeds Equipment Company Inc., 913-915 Main Street

KENTUCKY, Louisville, 13: Rudd Construction Equipment Co., Inc., 4344 Poplar Level Road

NORTH CAROLINA, Charlotte: Mitchell Distributing Co., Inc., 3535 Hutchison Ave., P.O. Box 1356

Raleigh: Mitchell Distributing Co., Inc., 5045 Hillsboro St. Extensions, P.O. Box 10365

Spruce Pine: Mitchell Distributing Co., Inc.

OHIO, Cadiz: The W. W. Williams Company, 700 Lincoln Ave.

Cincinnati 15: The W. W. Williams Co., 641 Reading Road, Reading

Cleveland: The W. W. Williams Co., 18301 Brookpark Road

Columbus 8: The W. W. Williams Co., 835 West Goodale Blvd.

Maumee: The W. W. Williams Co., 1230 Conant Street, P.O., Box 309

PENNSYLVANIA, Corry: Corry Bridge & Supply Co.

Devon: Road Machinery, Inc., U. S. Highway 30

Hazleton: W. N. Dippel, Inc., Route 924, P.O. Box 313

Mechanicsburg: American Equipment Corporations, York & Allen Streets, P.O. Box 149

Pittsburgh 6: Brinker Supply Co., 6545 Hamilton Avenue

TENNESSEE, Chattanooga: Story Brothers, Inc., 919 Dodds Avenue

Knoxville 18: Story Brothers, Inc., 4130 Clinton Highway, P.O. Box 4166

Memphis: Southland Tractors, Inc., 404 East Mallory Ave., P.O. Box 3187

Nashville 4: McCarthy, Jones & Woodward, 723 Argyle Ave., P.O. Box 9068

VIRGINIA, Richmond 12: Municipal Sales Co., Inc., 1823 North Hamilton Ave., P.O. Box 1518

WEST VIRGINIA, Charleston 28: Construction Equipment, Inc., 1915 Washington St., West P.O. Box 2388

Parkersburg: Construction Equipment Inc., Intersection Routes 2 & 21, P.O. Box 854

I

INGERSOLL RAND CO.
11 Broadway, New York 4, N. Y.

DISTRICT SALES OFFICES

ALABAMA, Birmingham 3: 1700 3d Ave., South, Fairfax 3-2576

COLORADO, Denver 2: 1641 Blake St., Keystone 4-2245

ILLINOIS, Chicago 6: 400 W. Madison St., Dearborn 2-4626-35

MISSOURI, St. Louis 3: 2227 Locust Blvd., Garfield 1-0888

NEW YORK, Buffalo 2: 117 W. Chippewa St., Cleveland 6437-8-9-40

New York 4: 11 Broadway, Digby 4-6070

OHIO, Cincinnati 6: 425 McGregor Ave., Plaza 1-8060

Cleveland 3: 4506 Chester Ave., Express 1-9889

PENNSYLVANIA, Philadelphia 3: 2037 Chestnut St., Locust 7-7535

Pittsburgh 22: 932 Penn Ave., Atlantic 1-9070-1-2-3

Scranton 9: 315 Walnut St., Diamond 2-8131

TENNESSEE, Knoxville 24: 412 W. Jackson Ave., Phone 2-3145-6-7

UTAH, Salt Lake City 1: 144 S. W. Temple St., Davis 8-8127

VIRGINIA, Richmond 21: 3431 W. Leigh St., Phone 5-2861

INTERNATIONAL HARVESTER CO. CONSTRUCTION EQUIPMENT DIVISION
180 North Michigan Ave., Chicago 1, Illinois

DISTRICT SALES OFFICES

ILLINOIS, Peoria: 407 Rock Island Ave., P.O. Box 1019

Quincy: 630 North Second St.

Springfield: 126 West Jefferson St, P.O. Box 99

KENTUCKY, Louisville: 1326 West Walnut St.

MARYLAND: Baltimore: 6501 Quad Ave.

OHIO, Cincinnati 1: 409 Lock St., P.O. Box 1759

Columbus 4: P.O. Box 797

Toledo 1: 43 Fearing St.

PENNSYLVANIA, Harrisburg: 1017 Maclay St.

Leetsdale: 1000 Ferry St.

TENNESSEE, Memphis 2: 237 West Olive Ave., P.O. Box 2864

VIRGINIA, Richmond 23: 1709 East Clay St.

DISTRIBUTORS

ILLINOIS, East Peoria: McElroy-Roland Machinery Co., 2580 Morton Road

Quincy: Missouri-Illinois Tractor & Equipment Co., Inc. U.S. Highway No. 24, Box 328

Rockford: Howell Tractor & Equipment Co, Route 51 & Samuelson Road

Springfield: McElroy-Roland Machinery Co., 719-21 East Jefferson St.

KENTUCKY, Louisville: Brandeis Machinery & Supply Co., 201 Warnock St., Box 1705

Middlesboro: Brandeis Machinery & Supply Co., North 19th St. Box 515

Paducah: Brandeis Machinery & Supply Co., U.S. Hwy. 45, Box 906

MARYLAND, Baltimore: Phillips Machinery & Tractor Co, 325 West 23rd St., Box "O" Hampden Station

OHIO, Cincinnati: Rish Equipment Co., 1212 Dalton Ave., Box 120

Cleveland: Rish Equipment Co., 9255 Brookpark Road, Box 7303

Columbus: Rish Equipment Co., 3131 Beulah Road, Box 6398

Dayton: Rish Equipment Co., 2375 Dryden Road, Box 543

Portsmouth: Rish Equipment Co., North on U.S. Route 23, Box 270

Toledo: Rish Equipment Co., 101 North Westwood, Box 206

Youngstown: Rish Equipment Co., 250 Indinola Ave., Box 2669

PENNSYLVANIA, Franklin: State Equipment Co., 655 Grant St.

Harrisburg: State Equipment Co., 3725 North Front St., Box 412

Kingston: State Equipment Co., 842 West Market St.

Philadelphia 43: Stewart Equipment Co. of Philadelphia, 52nd & Woodlawn Ave.

Philipsburg: State Equipment Co. Box 667

Pittsburgh: State Equipment Co. 8436 Perry Highway

TENNESSEE, Chattanooga, 5: Power Equipment Co., 1080 Duncan Ave., Box 3158

Kingsport: Power Equipment Co., 121 Clay St., Box 348

Knoxville 15: Power Equipment Co., 1430 Island Home Ave., S.E.

Nashville 3: Power Equipment Co. of Nashville, 808 Sixth Ave., North

VIRGINIA, Arlington: Phillips Machinery & Tractor Co., 2910 Jefferson Davis Highway

Norfolk 8: Hampton Roads Tractor & Equipment Co., Inc., West 39th St. & Killiam Ave., Box 237

Richmond 10: Rish Equipment Co. 405 Center Ave., N.W., Box 1260

Roanoke 7: Rish Equipment Co. 405 Center Ave., N.W. Box 1369

WEST VIRGINIA, Bluefield: Rish Equipment Co., Box 269

Bluefield: Rish Equipment Co., North on U. S. 52, Box 1261

Charleston 22: Rish Equipment Co., Kanawha Boulevard at Patrick St., Box 353

Clarksburg: Rish Equipment Co. East on U.S. Route 50, Box 2227

Parkersburg: Rish Equipment Co., 140 Nineteenth St., Box 1728

J

THE JEFFREY MFG. CO.
974 North Fourth St., Columbus 16, Ohio

ALABAMA, Birmingham 5: 3012 Fourth Ave., South, Fairfax 2-8516

COLORADO, Denver 2: 1726 Champa St., Suite 315

INDIANA, Evansville 7: 1066 Diamond Ave., Harrison 4-8206

KENTUCKY, Harlan: Martins Fork Road, P. O. Dr. 472 Phone: 400

PENNSYLVANIA, Johnstown: Box 731, Davenport 5-7165

Pittsburgh 22: 1424 Oliver Bldg., Court 1-2926

UTAH, Salt Lake City 16: 15-N West Temple Street, Suite D Empire 48848

WEST VIRGINIA, Beckley: 403-405 City Ave., P.O. Box 231, Clifford 3-7321

Bluefield: 1703 Jefferson St., P.O. Box 731, Davenport 5-7165

Gilbert: P.O. Box 425, Morris 4-3234

Morgantown: P.O. Box 873

SERVICING AGENTS

INDIANA, Evansville: Evansville Electric & Mining Co.

KENTUCKY, Harlan: National Electric Service Corp.

PENNSYLVANIA, Portage: Leman Machine Co.

WEST VIRGINIA, Bluefield: National Electric Coil Co.

JOY MFG. CO
Henry W. Oliver Bldg., Pittsburgh 22, Pa.

DISTRICT SALES OFFICES

COLORADO, Denver 2: 1626 Wazee St., Keystone 4-6334

DISTRICT OF COLUMBIA, Washington 6: 1741 K. St., N.W., Executive 3-6200

ILLINOIS, Centralia: 5th & Chestnut Phone 2-4707

Chicago 6: 560 W. Washington Blvd., Dearborn 2-4670

MISSOURI, St. Louis 10: 1203 Macklind Ave., Mission 5-6670

MONTANA, Butte: 24 W. Granite St., Phone 6721

NEW YORK, New York 6: 140 Cedar St., Cortlandt 7-6545

OHIO, Cleveland 35: 16141 Puritan Ave., Clearwater 1-9444

OREGON Portland 9: 1631 N.W. Thurman St., Capital 7-5561

PENNSYLVANIA, Luzerne: 453 Main St., Butler 8-4523

Philadelphia 2: 1420 Walnut St., Pennypacker 5-1414

Pittsburgh 16: 3021 Banksville Rd., Locust 3-4000

TENNESSEE, Knoxville 2: 108 W. Main St., Phone 24121

TEXAS, Dallas 20: 7425 Hines Blvd., Fleetwood 73949

UTAH, Salt Lake City 4: 998 S. Sixth West St., Davis 2-0481

WASHINGTON, Seattle 1: 2411 Western Ave., Mutual 2266

WEST VIRGINIA, Fairmont: P.O. Box 1045, Phone 1740

Huntington: 742 8th Ave., Jackson 3-3439

DISTRIBUTORS

ALABAMA, Birmingham: Crandall Engineering Co., 601 N. 10th St., Alpine 1-9262

COLORADO, Denver 2: Schloss & Shubart, 1626 Wazee St., Acoma 2-2741

JOY MFG. CO., ELECTRICAL PRODUCTS DIV.
1205 Macklind Ave., St. Louis, Mo.

K

KENNAMETAL INC., MINING TOOL DIV.
Bedford, Pa., Phone 755

DISTRICT SALES OFFICES

ILLINOIS, Benton: 1307 N. Main St., Phone 8-8811

INDIANA, Vincennes: 224 Wilbur St., Phone 3299

KENTUCKY, Barbourville: 419 S. Main St., Box 337, Lincoln 6-3727

Belfry: Box 28, Phone Williamson, W. Va. AD 7-4468

OHIO, Crooksville: 303 Walnut St., Phone 4104

PENNSYLVANIA, Cadogan: Phone: Roger 29964

Glenshaw: 107 Orchard Ave., Hunter 6-5722

Latrobe: 215 Loyalhanna Ave., Keystone 74333

Mars: Box 236 National 5-9011

Rimersburg: Box No. 289, Phone 113

Waynesburg: Morning Side, RD No. 3. Phone 1734 (Orval Robson) Phone: 1076

Wyoming: 41 Shulde Lane, Phone: Wyoming 49

TENNESSEE, Chtttanooga 11: 1314 S. Seminole Dr., Oxford 83021

UTAH, Springville: 164 W. 2 S., Hunter 9-5541

WEST VIRGINIA, Bluefield: Box No. 834, Davenport 7-8376

Morgantown: P.O. Box 1133, Phone 9503

Oak Hill: 368 Kelly Ave., Hobart 9-9744

DISTRIBUTORS

ALABAMA, Birmingham: Salmon & Co., Inc.

KENTUCKY, Jenkins: National Mine Service Co.

Madisonville: National Mine Service Co.

NEW MEXICO, Carlsbad: Bit Grinding Service Inc.

PENNSYLVANIA, Forty-Fort: National Mine Service Co.

Indiana: National Mine Service Co.

Latrobe: McGinnis Bros. Bit Service Inc.

Washington: Fairmont Supply Co.

VIRGINIA, Andover: Central Supply Service of Virginia Inc.

McClure: Erwin Supply Co.

WEST VIRGINIA, Beckley: National Mine Service Co.

Bluefield: Fairmont Supply Co.

Cowen: Pennsylvania & West Virginia Supply Corp.

Fairmont: Fairmont Supply Co.

Logan: National Mine Service Co.

Morgantown: National Mine Service Co., Pennsylvania & West Virginia Supply Corp.

Ravenswood: Fairmont Supply Co.

Shinnston: Erwin Supply Co.

Triadelphia: Pennsylvania & West Virginia Supply Corp.

KERSEY MANUFACTURING CO., INC.
P. O. Box 151, Bluefield, Virginia, Fairfax 6-1121

DISTRICT SALES OFFICES

KENTUCKY, London: Volunteer 4-4891

VIRGINIA, Oakwood: Hylite 8-29-5

Wise: Phone 2131

KOPPERS COMPANY, INC., WOOD PRESERVING DIV.

750 Koppers Bldg., Pittsburgh 19, Pa., Express 1-3300

DISTRICT SALES OFFICES

ALABAMA, Montgomery: P. O. Box 510 Amherst 3-3416

OHIO, Marietta: 102 Front St., Phone Frontier 3-6437

PENNSYLVANIA, Haverford: Box 389, 355-E Lancaster Ave., Midway 2-5854

Pittsburgh: Peoples First National Bank Bldg., Smithfield & 7th Streets Express 1-3300

KW-DART TRUCK CO.

1301 North Manchester Tfwy., Kansas City, Mo. HU 3-7679

FACTORY SALES OFFICES

NEW YORK, Long Beach: John C. Morley, 23 Virginia Ave.

OHIO, Cleveland: T. E. Sullenger, Westlake Hotel

DISTRIBUTORS

ALABAMA, Birmingham: Leary & Owens Machinery Co., 3600 5th Ave.

Montgomery: Leary & Owens Equipment Co., 3165 Mobile Ave.

COLORADO, Denver: Fincham Equipment, Inc., 1033 West Mississippi Ave.

ILLINOIS, Oaklawn: Tractor & Equipment Co., 10000 S. Ridgeland Ave.

INDIANA, Indianapolis: Sanstrom & Co., Inc., 2357 Kentucky Ave.

MISSOURI, Kansas City: Funkhouser Machinery Co., 2425 Jefferson St.

NORTH CAROLINA, Winston-Salem: J. W. Burress, 100 Waughtown St.

OREGON, Portland: Wood Tractor Co., 5241 N.E. 82nd Ave.

PENNSYLVANIA, Philadelphia: Constructors Equipment Corp., 345 North 57th St.

Lancaster: Box 1118

Pittsburgh: Watson Equipment Co., P.O. Box 9707

TENNESSEE, Nashville: McCarthy, Jones & Woodard, 723 Argyle Ave.

TEXAS, Dallas: Texas Kenworth Corp., 7901 Harry Hines Blvd.

UTAH, Salt Lake City: J. T. Jenkins Co., 2261 S.W. Temple St.

VIRGINIA, Roanoke: Southern Machinery Co., 2757 Shenandoah Ave., North

WEST VIRGINIA, Charleston: West Virginia Tractor & Equipment, P.O. Box 473

L

LEE-NORSE CO.

Charleroi, Pa., Hudson 3-6516

DISTRICT SALES OFFICES

COLORADO, Arvada: 6030 W. 55th Place, Harrison 4-2795

Boulder: 2975 18th Street, Hillcrest 3-6169

VIRGINIA, Pocahontas: Pocahontas Warehouse, Wilson 5-8345

WEST VIRGINIA, Bluefield: 112 Virginia Court, Davenport 5-8-7229

SALES AGENTS

ALABAMA, Birmingham: J. L. Thomas Company, 429 South 24th Street, Fairfax 4-7032

AUSTRALIA, Sydney, NSW. Noyes Bros. Pty. Ltd., 115 Clarence Street, Phone Bo254

LEMAN MACHINE CO.

P.O. Box 236, Portage, Pa. Pershing 6-2051

LE ROI DIVISION, WESTINGHOUSE AIR BRAKE CO.

Milwaukee 1, Wisc.

LeTOURNEAU—WESTINGHOUSE CO. WESTINGHOUSE AIR BRAKE CO.

Peoria, Illinois

DISTRIBUTORS

COLORADO, Denver: Tudor Equipment Co., 6198 Colorado Blvd., Atlas 8-1513

ILLINOIS, Marion: John Hutton Supply Co., P.O. Box 368, Phone 2-025

INDIANA, Indianapolis: Miller Machinery, Inc., 7255 W. Washington St., P.O. Box 5785, Chappel 1-2511

KENTUCKY, Lexington : Contractors Equipment Co., Inc., 780 E. 3rd St., Phone 2-1475

Louisville: Contractors Equipment Co., Inc., 4410 Poplar Level Rd., Glendale 8-3022

MONTANA, Billings: Western Constr. Equipment Co., 505 N. 24th St., P.O. Box 2537, Phone 9-5301

OHIO, Cleveland 30: Cleveland Contr. Equip. Co., 10904 Brookpark Rd., Shadyside 1-5570

Columbus 7: Columbus Equipment Co., 50 E. Kingston Ave., Hickory 3-6541

OKLAHOMA, Tulsa: Wylie-Stewart Mach. Co., Inc., P.O. Box 3216 Whittier Stat., 2443 Dawson Rd., Webster 9-5439

PENNSYLVANIA, Butler: Walsh Equipment Co., 208 S. Chestnut St., Butler 7-4996

Harrisburg: Furnival Machinery Co., 5101 Paxton St., P.O. Box 786, Cedar 8-1781

New Philadelphia: Furnival Machinery Co., Water St., P.O. Box 553, Market 2-8020

Philadelphia 21: Furnival Machinery Co., Lancaster Ave. at 54th St., Trinity 7-5200

Pittsburgh 23: A. T. Green Mach. Co., P.O. Box 9538, Sterling 1-9609

TENNESSEE, Chattanooga 1: Nixon Machinery & Supply Co., Inc., 1300 Carter St., P.O. Box 149, Am 7-5573

Knoxville: Nixon Machinery & Supply Co., Inc., 4717 Clinton Highway, P.O. Box 3034, Mutual 7-1601

Memphis: Tri-State Equipment Co., Inc., P.O. Box 2681, Jackson 5-3716

Nashville: Nixon Machinery & Supply Co., Inc., 1211 Demonbreun St., P.O. Box 2681, Jackson 5-3716

UTAH, Salt Lake City: Rocky Mt. Machinery Co., 1485 S. 2nd West St., P.O. Box 2037, Hunter 4-4378

VIRGINIA, Lynchburg: Richmond Machinery & Equip. Co., Inc., P.O. Box 1278, 3742 Campbell Ave., Phone 7-2737

LINATEX CORP. OF AMERICA

P.O. DRAWER "D" Stafford Springs, Conn.: or Wilkins Linatex, Ltd., 1975 Bois Franc Rd., St. Laurent, Quebec, Canada

DISTRIBUTORS

MISSOURI, St. Louis 10: Shutt Process Equipment Corp., 5627 Manchester St.

NEW JERSEY, Bayway: U.S. James Jr., 712 Rockefeller St.

PENNSYLVANIA, Pittsburgh 19: S. E. Gane Co., 508 Grant St.

UTAH, Salt Lake City 8: A. P. Robertson, 1347 South 17th East

LINCOLN ENGINEERING CO., DIV. of the McNEILL MACHINE & ENGINEERING CO.

4010 Goodfellow Block, St. Louis 29, Mo.

FACTORY SALES OFFICES

ILLINOIS, Chicago 16: Lincoln Engineering Co. of Ill., 2415 South Michigan Ave., CA 5-6022

OHIO, Cleveland 3: Lincoln Lubricating Systems, Inc., 4500 Euclid Ave., Express 1-4334

OREGON, Portland 14: Lincoln Engineering Co. of Calif., 1018 S. E. 8th Ave., Belmont 4-7469

PENNSYLVANIA, Philadelphia 40 6th & Annsbury St., Davenport 9-0790

Pittsburgh: 134-36 South Whitefield, Montrose 1-1444

TEXAS, Ft. Worth 7: Keller-Hyden, Inc., P.O. Box 9008, Pershing 8-5451

CANADA, Toronto 13, Ontario: Lincoln Engineering Co. (Canada) Ltd., 411 Birchmount Road, Oxford 8-2501

LINK-BELT COMPANY

Dept. CAMGL-59, Prudential Plaza, Chicago 1, Ill.

DISTRICT SALES OFFICES

ALABAMA, Birmingham 9: 321 Oxmoor Rd., Tremont 1-1101

COLORADO, Denver: Schloss & Shubart, 1626 Wazee St., Acoma 2-2741

ILLINOIS, Chicago 9: 301 W. Pershing Rd., Atlantic 5-4401

INDIANA, Indianapolis 6: 220 S. Belmont Ave., Melrose 2-5411

KENTUCKY, Louisville 8: 235 E. Burnett St., Melrose 7-3668

MICHIGAN, Detroit 4: 5938 Lindsdale Ave., Tyler 4-1100

MISSOURI, Kansas City 8: 2630 Holmes St., Victor 2-9234

St. Louis 1: 317 N. 11th St., Chestnut 1-1777

OHIO, Cleveland 20: 3592 Lee Rd., Wyoming 1-0380

PENNSYLVANIA, Pittsburgh 13: 5020 Center Ave., Museum 1-060

WASHINGTON, Seattle 4: 3405 6th Ave. S., Seneca 8200

WEST VIRGINIA, Huntington 1: 1009 5th Ave., P.O. Box 510, Jackson 3-9401

AUSTRALIA, Marrickville (Sidney): Rich St., P.O. Box 41

BRAZIL, Sao Paulo: Rua Barao de Utapetininga 46

CANADA, Scarboro Toronto 13 Ont: 1960 Eglinton Ave., P.O. Box 173 Station H, Plymouth 5-4141

SOUTH AFRICA, Springs: P.O. Box 287, Industry Rd., New Era Springs, Phone 56-4136

THE LONG CO.

P.O. Box 331, Oak Hill, West Virginia, Phone 1191

SALES AGENTS

ALABAMA, Birmingham 5: J. L. Thomas, 429 S. 24th Street

ILLINOIS, Chicago: Airdox-Cardox Products Co., 307 North Michigan Ave.

PENNSYLVANIA, Wilkes-Barre: Goodman Manufacturing Co., 35 New Bennet Street

LUDLOW-SAYLOR WIRE CLOTH CO.

634 S. Newstead Ave., St. Louis 10, Mo., Franklin 1-0636

DISTRICT SALES OFFICES

ALABAMA, Birmingham: 1727 6th Ave. N., Alpine 2-5151

CALIFORNIA, Los Angeles 65: (Star Wire Screen & Iron Works, Inc., 2515 San Fernando Rd., Capitol 5-4101

COLORADO, Denver: 1530 Carr St., Belmont 3-5421

ILLINOIS, Chicago: 5807 W. Diversey Ave., National 2-1147

PENNSYLVANIA, Pittsburgh: Union Trust Bldg., Atlantic 1-2262

TEXAS, Houston: 5638 Harvey Wilson Drive, Walnut 1-0291

LUKENS STEEL CO.

Coatesville, Pa.

DISTRICT SALES OFFICES

COLORADO, Denver 4: Room 104, Goby Bldg., 1321 Bannock St.

ILLINOIS, Chicago 4: Room 1042, McCormick Bldg., 332 South Michigan Ave.

OHIO, Cincinnati 37: P.O. Box 2633, 1720 Section Rd.

Cleveland 14: 1201 Citizens Bldg.

PENNSYLVANIA, Pittsburgh 19: 2005 Law & Finance Bldg., 429 Fourth Ave.

VIRGINIA, Richmond: 717-718 Central National Bank Bldg.

M

MACK TRUCKS, INC.

1355 W. Front St., Plainfield, N. J.

MARIETTA CONCRETE DIVISION, AMERICAN-MARIETTA CO.

Marietta, Ohio

DISTRICT SALES OFFICES

MARYLAND, Baltimore 21: Race Rd. & Pulaski Hghy. Phone: Murdock 7-5200

NEW YORK, Falconer: P.O. Box 158, Phone: 3-1836

NORTH CAROLINA, Charlotte: P.O. Box 5192, Fr 7-2060

OHIO, Marietta: P.O. Box 356 Fr 3-3211

TENNESSEE, Nashville: 411 Foster St., Andrew 3-1674

DISTRIBUTORS

ALABAMA, Birmingham: Dixon Supply Co., 425 S. 20th St., Phone: 54-4687

FLORIDA, Tampa: Peabody Sales, Inc., 9257 56th St., Webster 8-1118

GEORGIA, Atlanta: John C. Moore, 49 Peachtree Circle, N. E., Trinity 6-0398

ILLINOIS, Chicago: Mayer & Oswald, 407 S. Dearborn St., Harrison 7-0528

LOUISIANA, New Orleans: Carl Hoffman Co., 504 Delta Building, P.O. Box 4152, Raymond 2032

Westlake: Warren Industrial Sales P.O. Box 7, Phone: Lake Charles—Hemlock 9-8546

MASSACHUSETTS, Boston 15: Clark Engineered Products, 108 Massachusetts Ave., KE 6-5290

MICHIGAN, Ferndale 20: Beltaire Driesen 570 Livernois Ave., Jordan 4-5597 or 4-5598

MISSOURI, St. Louis 5: James B. Flaherty & Co., 7530 Forsythe Blvd., Pa. 5-2923 or Pa. 5-2924

NEW YORK, Geneva: Carlson Equipment Co., P.O. Box 507, Phone: 2196

Buffalo 14: Hohl Industrial Sales 1540 Niagara St., Am-2524

New York: Squires & Cole, 501 Fifth Ave., Murrayhill 7-3836

PENNSYLVANIA, Jenkintown: Alcar Builders' Specialties, P.O. Box 41, 200 York Rd. Turner 7-3790 or 7-3791

Pittsburgh 22: Mann Engineering Co. 503 Bessemer Bldg., Atlantic 1-2950

MANITOWOC ENGINEERING CORP.

S. 16th St., Manitowoc, Wis., Murray 4-6621

DISTRIBUTORS

CALIFORNIA, San Francisco 24: Fred E. Barnett Co., 1455 Custer Ave., Mission 8-2970

IOWA, Cedar Rapids: Moorman Equipment Co., 3028 Mt. Vernon Rd., S.E., Empire 3-2047

KENTUCKY, Madisonville: Hart Equipment Co., 122 E. Center, Ta 1-4645

OHIO, Columbus 8: W. W. Williams Co., The, 835 W. Goodale Blvd., Capital 8-6651

PENNSYLVANIA, Bridgeville: Anderson Equipment Co., P.O. Box 427, Lehigh 1-6020

MARION POWER SHOVEL CO.
Marion, Ohio

DISTRICT SALES OFFICES

ILLINOIS, Chicago: 332 S. Michigan Ave., Wabash 2-2701 & 2
NEW YORK, New York: 420 Lexington Ave., Murray Hill 9-6447

DISTRIBUTORS

ALABAMA, Oneonta: Robbins Machine & Mfg. Co., Inc., Highway 75, North, Crestwood 4-3011
INDIANA, Indianapolis: Flesch-Miller Tractor Co., 4611 Franklin Road, Liberty 6-2491
KANSAS, Pittsburg: Henry W. Hubert Supply Co., 814 North Broadway, Phone 579
MISSOURI, St. Louis: Ryan Equipment Co., 3350 Morgansford Rd.,Prospect 1-0292
OHIO, Cincinnati: Bode-Finn Co., 2650 Spring Grove Ave., Mulberry 1-2000
Dover: Weaver Truck Trailer & Body Corp., 2405-15 N. Wooster Ave., Phone 4-2391
PENNSYLVANIA, Carnegie: Allied Equipment Corp., 1 Glass St., Browning 9-5000
Philadelphia: Furnival Machinery Co., Lancaster Ave. at 54th St., Trinity 7-5200

McLANAHAN & STONE CORP.
Hollidaysburg, Pa., Phone 5-9807

DISTRIBUTORS

ALABAMA, Birmingham: Shook & Fletcher Supply Co., 1814 First Avenue, North, Fairfax 2-6722
KENTUCKY, Louisville: Elrod Equipment Co., 4517 Poplar Level Road, WO 9-2316
OHIO, Columbus: Cantwell Machinery Co., 830 N. Cassady Avenue, Clearbrook 8-9561
VIRGINIA, Roanoke: McIlhany Equipment Co., Inc., Corner 14th St. & Center Ave., N.W., Diamond 3-3669
WEST VIRGINIA, Charleston: Persingers Inc., 520 Elizabeth Street, Dickens 6-5341
Williamson: Persinger Supply Co., Belmont 5-1400

McNALLY PITTSBURG MFG. CORP.
307 W. 3rd St., Pittsburg, Kansas, Adams 1-3000

DISTRICT SALES OFFICES

ILLINOIS, Chicago: 307 N. Michigan Ave., Franklin 2-5172
OHIO, Wellston: P.O. Box 228, Phone 4-2181
AUSTRALIA, Glebe, N. S. W.: A. E. Goodwin Ltd., 47 Forsyth St.
BRAZIL, Rio de Janeiro: Formac, S.A., Caixa Postal, 1310

MERRICK SCALE MFG. CO.
184 Autumn St., Passaic, N. J.

DISTRICT SALES OFFICES

ILLINOIS, Oak Park: J. A. Marx, 400 West Madison St., Room 1904, FI 6-6786
MISSOURI, Kansas City 12: W. C. Carolan Co., 612 West 47th St., Jefferson 1-5505
St. Louis: W. C. Carolan Co., 4030 Chouteau Ave., Jefferson 5-5525
TENNESSEE, Chattanooga 2: Edgar A. Rogers, Chattanooga Bank Bldg., Amherst 7-4640
VIRGINIA, Richmond19: C. Arthur Weaver Co., Inc., 403 East Franklin St., Milton 31895-6
CANADA, Ontario, Toronto 9: Hagan Corp. (Canada) Ltd., P.O. Box 69, Station D, Roger 2-8285

MINE SAFETY APPLIANCES CO.
201 N. Braddock Ave., Pittsburgh 8, Pa., Churchill 1-5900

DISTRICT SALES OFFICES

ALABAMA, Birmingham: 2500 12th Ave., N., Alpine 4-3403
COLORADO, Denver: 2916 Forest St., Florida 51588
KENTUCKY, Harlan: Rio Vista, Phone 130
Pikeville: 416½ Second St., General 7-6675
MISSOURI, St. Louis 3: 1915 Washington Ave., Main 1-2252
MONTANA, Butte: 2419 Princeton Ave., Phone 6875
OHIO, St. Clairsville:
PENNSYLVANIA, Indiana: 241 Elm St., Phone: Hopkins 3-8850
Johnstown: 610 Johnstown Bank & Trust Bldg., Phone 7-0347
Pittsburgh 6: 7519 Penn Ave., Churchill 1-5900
Uniontown: 624 Fayette Nat. Bank Bldg., Geneve 8-7351
Scranton 10: 530 Clay Ave., Diamond 6-3062
UTAH, Salt Lake City 1: 257 Rio Grande St., Empire 4-6044
VIRGINIA, Norton: 840 Park Ave., Phone 888
WEST VIRGINIA, Bluefield: 1513 Bluefield Ave., Davenport 7-5171
Bridgeport: 523 Pennsylvania Ave., Victor 2-3230
Fairmont: 1313 Peacock Lane, Phone 909
Logan: P.O. Box 1306, Plaza 2-4959
Williamson: 38 Sunset Blvd., Belmont 5-5330
CANADA, Calgary, Alberta: 3632 Burnsland Rd., Chestnut 3-4092
Nova Scotia, Sydney: 150 Charlotte St., Phone 8370
Ontario, Toronto 4: 500 Macpherson Ave., Walnut 5-1101
Vancouver, B. C.: 3754 W. Tenth Ave., Alma 1127

MORRIS MACHINE WORKS
Baldwinsville, N.Y.

DISTRICT SALES OFFICES

ILLINOIS, Chicago 6: 205 W. Wacker Dr., RA 67174 & 5
NEW YORK, New York 1: 254 W. 31st St., PE 6-4723
NORTH CAROLINA, Charlotte 3: 518 E. Morehead St., FR 7-2678, LD 930
OHIO, Cleveland 14: 446 Leader Bldg., CH 1-5654

SALES AGENTS

COLORADO, Denver: Hack Engineering Co., 124 Waxee Market, TA 5-5248
MARYAND, Baltimore 18: Jobe & Co., 344 E. 23rd St., BE 5-3503 & 5-5033
MISSOURI, Kansas City 5: Lee Mathews Machinery & Rental Co., 318 Broadway, Baltimore 1-0650
OREGON, Portland 4: E. A. Finkbeiner, Lewis Bldg., Capitol 8-2191
PENNSYLVANIA Philadelphia 4: Maleson Co., 225 N. 32nd St., EV 2-6400
Pittsburgh 22: Ramsay Pump & Supply Co., 1701-3 Keenan Bldg., CO 1-1155-6
Scranton: J. A. MacFadyen Co., 537 Washington Ave., DI 2-3993
TENNESSEE, Chattanooga 2: Edgar A. Rodgers, Chattanooga Bank Bldg., AM 74640
TEXAS, Houston 1: Alliger & Sears Co., 2203 Fannin (Box 2217), CA 4-6933
UTAH, Salt Lake City 10: Lang Co., 1st S. & 2nd West, Phone 3-5831
VIRGINIA, Richmond 19: O'Neil Pump & Engineering Co., 601 E. Franklin St., Phone 7-4828
WASHINGTON, Seattle 4: Olympic Supply Co., 1743 1st Ave., S. Seneca 0416
WEST VIRGINIA, Charleston: Cross Pump & Equipment Co., 2853 Piedmont Rd., Walnut 5, 5822
CANADA, British Columbia, Vancouver: A. B. Wing Ltd., 1383 Hornsby St., Tatlow 7531
Quebec, Montreal: F. H. Hopkins & Co., Ltd., 8500 Decarie Blvd., Phone 21-74737
Ont., Toronto: Taylor Engineering & Const. Co., 111 Stephenson Ave., OX 9-1139

MINERS' HARDWARE SUPPLY CO.
Martin Bldg., Pittsburgh 12, Pa., Fairfax 1-3013 & Allegheny 1-7257

DISTRIBUTORS

PENNSYLVANIA, Pittsburgh 12: 821 Moravian Way
WEST VIRGINIA, Bluefield: A. W. Hageman, Box 241

N

NACHOD & UNITED STATES SIGNAL CO., INC.
4780 Crittenden Dr., Louisville 9, Ky., Emerson 3-3571

SALES OFFICES

UTAH, Salt Lake City: 375 South West Temple, DA 2-4311

NATIONAL ELECTRIC COIL DIV., McGRAW-EDISON COMPANY
Columbus 16, Ohio, 800 King Ave., Hudson 8-1151

DISTRICT SALES OFFICES

ALABAMA, Birmingham 3: 427-28 Brown-Marx Building, Alpine 1-8486
ILLINOIS, Chicago 4: 224 South Michigan Ave., Wabash 2-8102
KENTUCKY, Harlan, (National Electric Service Corp.) Box 840, Tel. 753-754
PENNSYLVANIA, Philadelphia 3: Transportation Center Bldg. 6 Penn Center Plaza, Locust 4-1480
WEST VIRGINIA, Bluefield: Bluefield Plant, Corner Bluefield Ave. & Beech St., Davenport 7-7195
CANADA, QUEBEC, St. Johns: National Electric Coil Canada Ltd. 450 St. Michel St., P.O. Box 248, Fidelity 8-3845, W L Hanson, Manager

NATIONAL MALLEABLE & STEEL CASTING CO.
10600 Quincy Ave., Cleveland 6, Ohio

NATIONAL MINE SERVICE CO.
Koppers Bldg., Pittsburgh 19, Pa.

DISTRICT SALES OFFICES

ILLINOIS, Nashville
KENTUCKY, Ashland
Jenkins
Madisonville
PENNSYLVANIA, Forty Fort
Greensburg
Indiana
WEST VIRGINIA, Beckley
Logan
Morgantown
CANADA, Elliot Lake, Ontario: National Mine Service (Canada) Ltd.

NEW YORK CENTRAL SYSTEM
466 Lexington Ave., New York, N. Y.

NEW YORK RUBBER CORP.
100 Park Ave., New York 17, N. Y.

NOLAN CO., THE
Bowerston, Ohio, Phone 6-2771 & 62781

DISTRIBUTORS

ALABAMA, Birmingham: Amos A. Culp, 429 So. 24th St., Phone 54-7032
COLORADO, Denver 2: E. C. Horne Machinery Co., 1726 Champa St., Tabor 5-7015
ILLINOIS, Chicago: J. N. North Associates, P.O. Box 105, Harbert, Mich., New Buffalo, Mich., Lakeside 4106
PENNSYLVANIA, Pittsburgh: George C. Hutchinson, Jr., 800 Keenan Bldg., Atlantic 1-5860
UTAH, Castle Gate: Frank C. Memmott, P.O. Box 154, Phone Kennilworth, Utah, Granite 2-5094
WEST VIRGINIA, Huntington: Huntington Supply & Equipment Co., Huntington National Bank Bldg., Jackson 25562

O

OHIO BRASS CO.
360 North Main St., Mansfield, Ohio

DISTRICT SALES OFFICES

INDIANA, Evansville 13: 1414 S.E. First St., Harrison 2-2869
KENTUCKY, Neon: P.O. Box 187, Neon 2441
PENNSYLVANIA, Johnstown: 1513 Luzerne St., P. O. Box 301, Phone: 35-1274
Pittsburgh 22: 1017 Oliver Bldg., Mellon Sq., Atlantic 1-1727
WEST VIRGINIA, Bluefield: 424 Parkway, P.O. Box 1616, Davenport 5768-4
Fairmont: 1219 Bell Run Rd., Phone : 7379

SALES AGENT

ALABAMA Birmingham 2: Shook & Fletcher Supply Co., Agent 1814 First Ave., North, P.O. Box 2631, Fairfax 2-6722

OKONITE CO.
Passaic N.J., Prescott 7-0400

DISTRICT SALES OFFICES

ALABAMA, Birmingham: P.O. Box 428, Alpine 1-5293 & 4
ILLINOIS, Chicago: 6045 S. Knox Ave., Reliance 5-4415
MISSOURI, Kansas City: 1627 Main St., Grand 1-6991
St. Louis: 1231 Locust St., Chestnut 1-6043
OHIO, Cincinnati: 2904 Woodburn Ave., Avon 1-1350
PENNSYLVANIA, Philadelphia: 1158 Suburban Station Bldg., Rittenhouse 6-8828
Pittsburgh: 535 Smithfield St., Atlantic 1-1202
Wilkes-Barre: 72 Hazle St., Valley 2-1144
UTAH, Salt Lake City: 1935 S. Main St., Hunter 4-7642
VIRGINIA, Bluefield: P.O. Box 509, Fairfax 6-1354

P

PENN MACHINE CO.
Johnstown, Pa.

DISTRICT SALES OFFICES

PENNSYLVANIA, Johnstown: 106 Station St., Phone 9-8715
Pittsburgh: 905 Porter Bldg., Court 1-2761
WEST VIRGINIA, Huntington: 410 West 15th St., Hamilton 9-1441

DISTRIBUTORS

ALABAMA, Birmingham: Salmon & Co., 609 North 9th St., Fairfax 4-0625
COLORADO, Denver: Union Supply Co., 5460 Colorado Blvd., Amherst 6-2292
ILLINOIS, Danville: W. M. Hales Co., 700 Commerce St., Phone 2398
Hillsboro: W. M. Hales Co., 719 S. Main St., Kellogg 23-115
West Frankfort: W. M. Hales Co., 501 N. Douglas St., Phone 1013 and 1016
KENTUCKY, Harlan: Kentucky Mine Supply Co., River St., Phone 1-500
Lothair: Mine Service Co., Inc., Phone 239
Madisonville: W. M. Hales Co.,
Pikeville: Big Sandy Electric & Supply Co., Phone 234
NEW MEXICO, Carlsbad: Wenzel's Parts Service, Tuxedo 54175
PENNSYLVANIA, Scranton: Heidenreich & Van Nostrand, 1658 North Main Ave., DI 4-1717
UTAH, Helper: Carbon Transfer & Supply Co., Inc., Granite 2-5641
VIRGINIA, McClure: Erwin Supply Co., Clinchco, 2311 and 2321

PHOENIX PRODUCTS CO.
4737 N. 27th St., Milwaukee 9, Wisc.

PLM PRODUCTS, INC.
3871 West 150th St., Cleveland 11, Ohio, Winton 1-9544

PORTER CO., INC., H.K., CONNORS STEEL DIV.
P.O. Box 158, Huntington, W. Va.

DISTRICT SALES OFFICES

ALABAMA, Birmingham: P. O. Box 2562

H. K. PORTER CO., INC., LESCHEN WIRE ROPE DIV.
2727 Hamilton Ave., St. Louis 12, Mo.

DISTRICT SALES OFFICES

CALIFORNIA San Francisco 7: 520 4th St.
ILLINOIS, Chicago 7: 810 W. Washington Blvd.
NEW JERSEY, Newark 5: 219 Emmet St.

SALES AGENTS

INDIANA, Indianapolis: J. G. Tierney, 6110 E. Marilyn Road
PENNSYLVANIA, Emmaus: D. D. Somers, 523 N. 6th St.
VIRGINIA, Richmond: 413 N. Stafford Ave.

DISTRIBUTORS

KENTUCKY, Harlan: Beck Electrical Repair Co.
Lothair: Mine Service Co.
PENNSYLVANIA, Pittsburgh 26: Cobb Wire Rope & Supply, 501 McNeilly Rd.
Hazelton: Jayem Supply Co. Hazelton-McAdoo Hwy.
Clearfield: Clearfield Equipment Co.
WEST VIRGINIA, Bluefield: Bluefield Hardware Co.
Huntington: Logan Hdwe & Sup. Co., P.O. Box 1895
Logan: Logan Hdwe. & Sup., P.O. Box 540
Charleston 23: Capital City Sup. Co., 544 Broad St.
Clarksburg: Osborn Machy. Co., Inc.
Kermit: Controller Block & Sup. Co.
Shinnston: Erwin Sup. & Hdwe. Co., Inc.
Elkins: Valley Supply Co., Inc.
TENNESSEE, Nashville: Buford Bros., Inc., 125-10th Ave. S.
Knoxville: Tidewater Sup. Co 1506 Island Home Ave SE
OHIO, Cleveland 10: Air Compressors Rental Co, 19615 Nottingham Rd
Zanesville: Goss Supply Co 620 Marietta St.
Canton: Ralph Williams, Inc., 429 Waynesburg Rd.
INDIANA, Boonville: Vernon Hardware Co., West Side Square
Terre Haute: B. F. Crawford Co., 1921 So. Third St.
VIRGINIA, Norton: Norton Hardware Co., 415 Park Ave.

PORTER CO., INC., H.K., THERMOID DIV.
Tacony & Comly Sts., Philadelphia 24, Pa.

POST-GLOVER ELECTRIC CO.
Box 709, Covington, Ky.

CALIFORNIA, Los Angeles: 4651 Pacific Blvd., Ludlow 8-4254
San Francisco (South), 168 Beacon St., Plaza 6-6981
COLORADO, Denver: 4500 York St., Acoma 2-8264
ILLINOIS, Chicago: 6010 North west Highway, Rodney 3-2400
NEW YORK, New York: 500 Fifth Ave., Bryant 9-4390
OHIO, Cleveland: 20950 Center Ridge Road, Edison 1-7230
PENNSYLVANIA, Philadelphia: 1138 Suburban Station Building, Rittenhouse 6-8310
Pittsburgh: 810 Empire Building, Atlantic 1-3544

REPUBLIC STEEL CORP.
Cleveland 1, Ohio

DISTRICT SALES OFFICES

ALABAMA, Birmingham 13:
CALIFORNIA, Los Angeles 17: San Francisco 5:
COLORADO, Denver 2:
CONNECTICUT, East Hartford 8:
FLORIDA, Jacksonville 2:
ILLINOIS, Chicago 4:
INDIANA, Indianapolis 4:
KENTUCKY Louisville 2:
LOUISIANA, New Orleans 12:
MASSACHUSETTS, Boston 16:
MICHIGAN, Detroit 2:
Grand Rapids 2:
MINNESOTA St. Paul 1:
MISSOURI, Kansas City 5:
St. Louis 3:
PENNSYLVANIA, Philadelphia 3:
Pittsburgh 22:
NEW YORK, Buffalo 3:
New York 17:
Syracuse 2:
OHIO, Cincinnati 2:
Cleveland 1:
Dayton 2:
Warren, (Youngstown District)
OKLAHOMA, Tulsa 3:
TEXAS, Dallas 1:
Houston 2:
WASHINGTON, Seattle 1:
WISCONSIN, Milwaukee 2:
CANADA, ONTARIO, Toronto: Commerce & Transportation Building

REYNOLDS METALS CO.
P.O. Box 2346, Richmond 18, Va.

DISTRIBUTORS

COLORADO, Denver: Union Supply Co., 5460 Colorado Blvd.
Denver: Western Machinery Co., 2400 W. 7th St.
INDIANA, Evansville: Austin Powder Co., 616-24 N. W. 2nd St.
KENTUCKY, Paducah: Petter Supply Co.
PENNSYLVANIA, Bethlehem: Bethlehem Aluminum Co.
WEST VIRGINIA, Bluefield: Bluefield Supply Co.
Charleston: McJunkin Corp; Box 813
Charleston: Persinger, Inc.
Holden: Island Creek Stores
Williamson: Persinger Supply

R

RAYBESTOS-MANHATTAN, INC., MANHATTAN RUBBER DIV.
Passaic, New Jersey

DISTRICT SALES OFFICES

ALABAMA, Birmingham: 1108 Fifth Avenue N., Alpine 15272

ROBERTS & SCHAEFER CO., DIV. OF THOMPSON-STARRETT CO., INC.
201 N .Wells St. Chicago 6, Ill., Central 6-7292

DISTRICT SALES OFFICES

PENNSYLVANIA, Pittsburgh 22: 1315 Oliver Bldg., Atlantic 1-8608
WEST VIRGINIA, Huntington: 916 5th Ave., Phone 3-4272

JOHN A. ROEBLING'S SONS CORP., SUBSIDIARY OF THE COLORADO FUEL AND IRON CORP.
Trenton 2, New Jersey

DISTRICT SALES OFFICES

COLORADO, Denver 16: 4801 Jackson St., Fremont 7-2769
GEORGIA, Atlanta 10: 934 Avon Ave., S.W., Plaza 3-2151
ILLINOIS, Chicago 50: 5525 West Roosevelt Road, Bishop 2-1100
OHIO, Cincinnati 15, Evendale: 2340 Glendale-Milford Road, Princeton 1-6990
Cleveland 7: 13225 Lakewood Heights Blvd., Clearwater 2-6060
PENNSYLVANIA, Philadelphia 6: 230 Vine St., Market 7-2751
WASHINGTON, Seattle 4: 900 First Ave., South, Main 4992

ROME CABLE CORP.
Rome, New York

DISTRICT SALES OFFICES

ILLINOIS, Chicago 39: 4505 West Grant Ave., Spaulding 2-2700
PENNSYLVANIA, Pittsburgh 22: 414 Oliver Bldg., Atlantic 1-0816

DISTRIBUTORS

KENTUCKY, Lothair: Mine Service Co., Inc., General 6-3151
Middlesboro: Rogan & Rogan, Middlesboro 89
Pikeville: Big Sandy Electric & Supply Co., P .O. Box 162 General 7-6296
PENNSYLVANIA, Pittsburgh 3: Muschach Electric & Supply Co., 1115 Arlington Ave., Hemlock 1-8332
Washington: Fairmont Supply Co., 437 Jefferson Ave., Baldwin 2-5200
WEST VIRGINIA, Beckley: Anchor Sales Co., P. O. Box 210, Clifford 3-9400
Bluefield: Fairmont Supply Co., U.S. 52, North, Davenport 5-6186
Charleston: Virginian Electric Inc., P.O. Box 2833, Dickens 6-0631
Charleston: Line Supply Co., Walnut 5-9098
Cowen: Pennsylvania & West Virginia Supply Corp., Cowen 2601
Elm Grove: Pennsylvania & West Virginia Supply Corp., Lindne 7-4710
Fairmont: Fairmont Supply Co., 10th & Belt Line, Fairmont 2110
Morgantown: Pennsylvania & West Virginia Supply Corp., Morgantown 4435
Wheeling: Pennsylvania & West Virginia Supply Corp., P.O. Box 871

S

SALEM TOOL CO., THE
767 S. Ellsworth Ave., Salem, Ohio, Edgewood 7-3416

DISTRIBUTORS

ALABAMA, Birmingham 4: Cowin Co., 930 2nd Ave. N.
ARKANSAS, Fort Smith: R. A. Young & Son, Inc.
Little Rock: R. A. Young & Son, Inc., 301 S. 10th St.
COLORADO, Denver 16: Union Supply Co., 5460 Colorado Blvd.
IDAHO, Boise, Intermountain Equipment Co., Broadway at Myrtle Sts.
ILLINOIS, Mt. Vernon: Ed. Mey Tractor Co.
INDIANA, Evansville: Austin Powder Co., Box 177
IOWA, Des Moines: Herman M. Brown Co., First & Sheridan
KANSAS, Pittsburg: W. A. Thomas Supply Co., 112-114 W. Pacific
KENTUCKY, Lexington 6: Wilson Machinery & Supply, 561 W. 4th St.
MONTANA, Helena: Hall-Perry Machine Co., 123 E. Lawrence St.
NEW YORK, New York 6: Exdevco Corp., 19 Rector St.
OHIO, Cincinnati 14: Rish Equipment Co., P.O. Box 120 (Annex Sta.)
Cleveland 29: Rish Equipment Co. P.O. Box 7303
Columbus 11: Rish Equipment Co., P.O. Box 6398, Oakland Park Branch
Dayton 9: Rish Equipment Co., P.O. Box 543
Portsmouth: Rish Equipment Co., P.O. Box 270
Steubenville: Voto Mfg. & Sales Co., 525 N. Webster
Toledo 7: Rish Equipment Co., P.O. Box 206 (Sta. C)
Youngstown 7: Rish Equipment Co., 250 E. Indianola Ave.
OKLAHOMA, Tulsa: R. A. Young & Son, Inc., 9401 E. Admiral Pl.
PENNSYLVANIA, Bethel Park: Whitmyre Equipt. Co., H., 336 Sunset Drive
Harrisburg: Capitol Equipment Co., Box 21, Hill Sta., 1151 S. 21st St.
SOUTH DAKOTA, Sioux Falls: L. G. Everist, Inc., 201 Paulton Bldg.
TENNESSEE, Knoxville: Nixon Machinery & Supply Co., 3042 N. Central Ave.
VIRGINIA, Richmond: Rish Equipment Co., P.O. Box 1260
Roanoke: Rish Equipment Co., P.O. Box 1369
WASHINGTON, Seattle 4: Clyde Equipment Co., 3410 1st Ave. S.
Seattle 4: The Carrington Co., 91 Columbus St., (Alaskan Representative)
WEST VIRGINIA, Bluefield: Rish Equipment Co., P. O. Box 269
Charleston 22: Rish Equipment Co., P.O. Box 353
Clarksburg: Rish Equipment Co., P.O. Box 2227
Parkerburg: Rish Equipment Co., P.O. Box 1728
CANADA, Montreal, Que: Mussens Canada, Ltd., 65 Colborn St.

SANFORD-DAY IRON WORKS, INC.
Dale Ave., P.O. Box 1511, Knoxville 9, Tenn.

SCANDINAVIA BELTING CO.
112 Keswick Ave. P.O. Box 949, Charlotte 1, No. Carolina

DISTRIBUTORS

ILLINOIS, Nashville: Clarkson Div. of National Mine Service
KENTUCKY, Ashland: Ashland Div. of National Mine Service
Jenkins: Va. Div of National Mine Service
PENNSYLVANIA, Forty Fort: Anthracite Div. of National Mine Service
INDIANA: Whiteman Div. of National Mine Service
Greensburg: Greensburg Div. of National Mine Service
Pittsburgh 19: National Mine Service Co., Suite 2530, Koppers Bldg.
WEST VIRGINIA, Beckley: Bemeco Div. of National Mine Service
Logan: All-State Div. of National Mine Service
Morgantown: Mountainer Div. of National Mine Service

SCHRAMM, INC.
870 E. Virginia Ave., West Chester, Pa.

SHELL OIL CO.
50 West 50th Street, New York, 20, N.Y.

DISTRICT SALES OFFICES

ILLINOIS, Chicago 5: 624 South Michigan Avenue, Harrison 7-3080

INDIANA, Indianapolis 4: 450 North Meridian Street, Melrose 5-8321

LOUISIANA, New Orleans 12: P.O. Box 673 (Zone 7), Express 1331

MARYLAND, Baltimore 4: P.O. Box 6870, Valley 5-5600

MISSOURI, St. Louis 66: P.O. Drawer 522, Volunteer 3-0300

SIMPLEX WIRE & CABLE CO.

79 Sidney St., Cambridge 39, Mass.

SINCLAIR REFINING CO.

600 Fifth Ave., New York 20, N.Y.

DISTRICT SALES OFFICES

ALABAMA, Birmingham 11: P.O. Box 37 Powderly Stn.

ILLINOIS, Springfield: 801 Illinois Bldg., P.O. Box 1240

INDIANA, Claremont: P.O. Box 136

KENTUCKY, Louisville 2: P. O. Box 1320

NORTH CAROLINA, Charlotte 8: P.O. Box 8067

OHIO, Worthington: P.O. Box 31

PENNSYLVANIA, Greensburg: P.O. Box 788
Mechanicsburg: P.O. Box 70

TENNESSEE, Nashville: P.O. Box299

VIRGINIA, Richmond: 10 South 10th St.

SKF INDUSTRIES, INC.

P.O. Box 6731, Philadelphia 32, Pa.

SPENCER CHEMICAL CO., INDUSTRIAL CHEMICALS DIV.

401 Dwight Bldg., Kansas City 5, Mo.

SPRENGNETHER INSTRUMENT CO., INC., W.F.

4567 Swan Ave., St. Louis 10, Mo.

THE W. R. STAMLER CORP.

P.O. Box 90, Paris, Kentucky

SALES AGENTS

ALABAMA, Birmingham 1: Salmon and Co., Inc., 609 North 9th St., F.A. 4-0625

NEW MEXICO, Carlsbad: Union Industrial Corp., P.O. Box 710, Tuxedo 5-2186

PENNSYLVANIA, McKees Rocks: Schroeder Bros. Corp., Nichol Ave., Box 72, Spaulding 1-4810

UTAH, Salt Lake City: Western Sales and Engineering Co., 375 South West Temple Ave., Davis 2-4311

STANDARD OIL COMPANY (INDIANA)

910 S. Michigan Ave., Chicago 80, Ill.

SUN OIL CO.

1608 Walnut St., Philadelphia 3, Pennsylvania, KI 6-1600

DISTRICT SALES OFFICES

ILLINOIS, Chicago 4: 310 So. Michigan Ave., 28th Floor, Harrison 7-2562

INDIANA, Indianapolis: 715 E. 52nd St., Walnut 4-4513

KENTUCKY, Louisville 2: 304 W. Liberty St., Spring 6-4681

MISSOURI, St. Louis 3, 3419 Papin St., Prospect 1-9364

OHIO, Cincinnati 4: 2414 River Rd., Wabash 1-5500
Columbus 4: 3499 W. Broad St., Broadway 9-9421
Youngstown 12: 6331 Southern Blvd., Skyline 8-4581

PENNSYLVANIA, Allentown, Old Emmaus Pike, R. D. 2, Hemlock 4-9531
Brownsville: Route 88 W. Brownsville, State 5-7400
Exeter: 7 Kern St., Olympic 4-6795
Greensburg: Roosevelt Way & Route 119, Greensburg 5400
Johnstown: Tunnel Ave., Riverside Johnstown 33-2111
Pittsburgh 38: Freeport Road & Boyd Ave., Sterling 1-1252

WEST VIRGINIA, Huntington: 12th & Beach Sts., Kenova, Gladstone 3-1381
Wheeling: Stop No. 22, River Road, Warwood 148

SUTPHEN, PETER O.

P.O. Box 58, Everett, Pa.

T

TEMPLETON, KENLY & CO. BROADVIEW, ILL.

DISTRICT SALES OFFICE

PENNSYLVANIA, Pittsburgh: 245 Marbrick Ave., Fieldbrook 1-6357

DISTRIBUTORS

ALABAMA, Birmingham: Lewis Hardware Co., 420 N. 9 St.; Moore-Handley Hardware Co., 27 S. 20th St., Wimberly & Thomas Hardware Co., 1809 Ave. A.

COLORADO, Denver: Mine & Smelter Supply Co., Inc., 3800 Race St.

ILLINOIS, Du Quoin: Du Quoin Iron & Supply Co., Inc., P.O. Box 181
Marion: N. O. Nelson Co., 600 N. Van Buren St.
Mt. Vernon: Central Mine Supply Co., Box 538
Murphysboro: Egyptian Sales Agency, 401 S. 17th St.
Peoria: Couch & Heyle, 1016 S. Adams

INDIANA, Evansville: Austin Powder Co., Inc., 616 N.W. 2d St., Drillmaster Supply Co., 1117 E. Division St.; Orr Iron Co., 1100 PennsylvaniaSt.
Terre Haute: Hardware Supply Co., Inc., 930-940 Chestnut St. Industrial Supply Co, 322-328 N. 9th St.
Mechanical Suppliers, Inc., 100 N. 9th St.

KANSAS, Pittsburg: General Machinery & Supply Co., 202 N. Bradway

KENTUCKY, Harlan: Kentucky Mine Supply Co., River St.
Hazard: Sterling Hardware Co., Inc., 124 Main St.
Madisonville: Austin Powder Co., 39 Federal St.
Paducah: Henry A. Peter Supply Co., 101-129 S. 1st St.

OHIO, Cambridge: Cambridge Machinery & Supply Co., 128 Steubenville Ave., Drawer 426
Cincinnati: Wm. T. Johnston Co., 1870 Summit Rd.; E. A. Kinsey Co., 331 W. 4th St.
Steubenville: Industrial Supplies Co., 324 N. 7th St.
Warren: Bert Park Co., 1199 Vine Ave., N.E., Warren Hdwe. Co., P.O. Box 1191
Zanesville: Buckeye Supply Co, 18 Harrison St.

OKLAHOMA, Oklahoma City: Marshall Supply & Equipment Co., 1241 West Main St., Mideke Supply Co., 160 E. Main St.
Tulsa 1: Leland Equipment Co., 408 Main St., Marshall Supply & Equipment Co., 920 E. Archer

PENNSYLVANIA, Bethel Park: Cooke-Wilson Electric Supply Co., 3000 Oakhurst Rd.
California: California Hardware & Supply Co., 344 3d St.
Forty Fort: National Mine Service
Greensburg: Westmoreland Hardware Co., 326 Mt. Pleasant St.
Indiana: Whitman Div. of National Mine Service Co., 1260 Maple St.
Johnstown: Quaker Sales Corp., P.O. Box 870; Thackray Co., 1036 Broad St.
Pittsburgh: C. A. Turner Inc., P.O. Box 928; Frich & Lindsay Co., Sandusky & Robinson Sts.; Harris Pump & Supply Co., Brady & Sidney Sts.; Pittsburgh Gage & Supply Co., P.O. Box 1168; Somer Filter & Todd Co., 327 Fort Pitt Blvd.
Scranton: Bittenbender Co., 126-132, Franklin Ave.
Washington: Fairmont Supply Co., 427 Jefferson Ave.
W. Brownsville: Ward Supply Co., Inc.
Wilkes-Barre: Eastern Penn. Supply Co. Inc.

TENNESSEE, Johnson City: Summers Hardware & Supply Co.
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1959 COAL AGE MINING GUIDEBOOK & BUYING DIRECTORY

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7—10RU Joy Mining Machines 250 volts DC, complete with permissible tags. Ready to go to work. Can be bought at a bargainprice.

4—512 Goodman AC Mining Machines, 3/60/220 volts, hydraulic type, and complete with bug-dusters, 9½' cutter bars.

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4—Allis Chalmers new type 200 KW motor generator sets. These sets were bought in 1948 and were only used a short time. They are beautiful sets and the specifications are as follows: DC end 250-275 volts, 723 amps, compound wound, 1200 RPM, direct connected to 300 HP Allis Chalmers synchronous motor, 3/60/2300 volts, 1200 RPM, complete with Clark fully automatic AC and DC enclosed portable controls. Just like brand new.

2—200 KW General Electric motor generator sets complete with automatic newtype controls for DC and AC end. AC end is 2300 volts, 1200 RPM and the DC end is 250 volts to 275 volts.

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6—11BU-11APE Joy Machines, 250 volts DC. Bargain priced.

5—Goodman G-20 Duckbills units 220 volts AC, complete with 300 ft. of pan line and duckbills.

LOCOMOTIVES

2—6 ton Mancha Whippet Battery Locomotives, 36" gauge.

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9—42E Joy shuttle cars complete with hydraulic elevating discharge. We are able to sell these at a bargain price.

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2—1500 KVA Moloney Transformers, primary voltage 33,000Y, secondary 2300/460, 3 phase, 60 cycles, type TC-R, 55° centigrade, impedence 6.75%, 5% taps. Steel tanks.

3—250 KVA Standard Transformers, single phase, type A, 60 cycles, 55°C rise, polarity substractive, impedence 75°C—5.6, high voltage 33000 low voltage 6900/11950Y. Steel tanks.

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5-W Bucyrus Erie Diesel Drag, 100', 6 yd.
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4500 Manitowoc Drag. 120', 5 yd.
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2—**Joy 14BU-7BG Loading Machines**
Curved bar head—220-440 volts A.C. 42" track gauge.

1—**Joy 14BU-8G Loading Machine**
250 volt D.C.—42" track gauge.

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250 volt D.C.—standard drive elevating boom.

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2—Joy 12-BU Loaders, 9E, latest type.
1—Joy 12-BU Loader, 220 volt AC.
1—Joy 20-BU Loader, latest type.
1—Joy 11-BU Loader, latest type.
1—Joy 8-BU Loader, 220 volt AC.
1—Joy 8-BU Loader, 34" overall height.
1—Joy 8-BU Loaders, 220 volt AC.
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4—Reliance 10-J Motors, 5 H.P.
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1—Goodman 660 Loader on cats, excellent.
1—Goodman 665 Loader on cats, latest type.
1—Goodman 865 Loader, 26" hi.
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3—Joy 6SC Shuttle Cars, latest type.
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2—Joy 32E10 Shuttle Cars, rebuilt.
2—Joy 32E15 Shuttle Cars, rebuilt.
4—Joy 32E16 Shuttle Cars, rebuilt
2—Joy 42E16 Shuttle Cars, rebuilt.
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1—Joy T-1 Standard Cat Truck, 250 DC.
2—Goodman low pan Cat Trucks, like new, latest type.
4—Joy 11-B Cutting Machines, like new. 35 & 50 H.P.
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2—Goodman 212 Cutting Machines, 19" high.
4—Goodman 312 Cutting Machines, 17" high.
3—Goodman 412 Cutting Machines, 19" high.
2—Joy 7-B Cutting Machines, 220/440 volt AC.
1—Goodman Machine on Cats, 31" high. All hydraulic
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1—Goodman 512 Cutting Machine, perfect.
3—Goodman 112 Cutting Machines, 220/440 volt AC.
1—Lee Norse low vein Machine Carrier on rubber.
1—Jeffrey 70 URB, rubber-tired Cutter, Universal head, perfect condition.
1—Joy 11RU Rubber Tired Cutters with bugdusters, Universal head, like new.
6—7AU's on track. Universal head.
2—Jeffrey 29UC Cutting Machines. Universal head, cuts anywhere in seam, 38" high, on cats, 250 volt D.C.

LOCOMOTIVES

1—Goodman 6 ton 91-A, 27" high, armor plate frame.
2—Jeffrey 13 ton, type MH-110, 36", 42" and 44" Ga.
2—Jeffrey 10 ton, type MH-110, 42" and 44" Ga.
2—Goodman 8-30 and 10-30 Locomotives, 26" above rail.
1—Jeffrey MH-124, 6 ton, 24" overall height.
12—Jeffrey, 6 ton, type MH-88, 42", 44" and 48" Ga.
4—Jeffrey, 8 ton, type MH-100, 2½" armor plate frames.
1—Jeffrey, 6 ton, type 2186, 22" above rail.
2—Jeffrey, 4 ton, type MH-96, 42", 44" and 48" Ga.
1—G.E., 4 ton, type 825 Locomotive, 22" high.
10—G.E., 6 ton, types 801, 803, 821 Locomotives, 42", 44" and 48" Ga.
1—G.E., 8 ton, type 822 Locomotive, 44" Ga.
3—G.E., 10 ton, type 809 Locomotives, 42", 44" and 48" Ga.
2—Goodman, type 33, 6 ton, 44" and 48" Ga.
3—Goodman, 8 ton, type 32A, 36", 44" and 48" Ga.
3—Westinghouse, type 902, 4 ton, 42" and 48" Ga.
2—Westinghouse, type 904, 6 ton, 44" and 48" Ga.
2—Westinghouse, type 906, 44" and 48" Ga.
2—Westinghouse, type 907, 10 ton, 44" and 48" Ga.
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4—Jeffrey MH-88 Locomotive Units, real bargains.
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2—Manitor Lines complete with Drums, excellent.
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1—Allis Chalmers 4 x 12 low-head Vibrator.
1—Robins Gyrex Vibrator, 4 x 10.
10—Belt and Apron type Loading Booms.
6—Shaker Screens.
1—Robins Car Shakeout.
20—Crushers, various sizes.
Feeders, Belt and Drag Conveyors, Car Retarders, etc.

CUTTING MACHINES

1—Joy 11RU's, rubber tired, Cutter.
1—Jeffrey 70 URB Cutter, rubber-tired, Universal Head, low vein.
2—Jeffrey 29UC Universal Machines on Cats.
6—7AU on track. Universal head.
1—Goodman on cats, 31" overall height.
3—Baby Goodman 212's, rebuilt, 250 volt DC.
2—Goodman 212 Cutting Machines, 19" high.
4—Goodman 321 Cutting Machines, 17" high.
3—Goodman 412 Cutting Machines, 19" high.
6—Goodman 512's with Bugdusters, like new.
4—Goodman 512's, rebuilt, or as removed from service.
3—Goodman 112's, 220/440 volt AC.
1—Joy 7-B Cutting Machine, 250 volt DC.
4—Joy 11B Cutting Machines, rebuilt, 35 & 50 H. P.
10—Goodman 12AA's and 112AA's, 250 v. DC.
2—Goodman 324 Slabbers.
2—Goodman 724 Slabbers.
6—Jeffrey 35L's, like new, 17" high.
2—Jeffrey 35L's, on low vein trucks.
15—Jeffrey 35B's and 35BB's.
2—Jeffrey 29B's on track.
2—Jeffrey 29C's track mounted.
2—Jeffrey 29L's on track, perfect.
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3—Sullivan CE7, 220 volt AC.

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6—Joy 12BU with Piggy-Back Conveyors
16—Joy Loaders, 8BU, 11BU, 12BU, 14BU, 20BU.
2—Goodman 865 Loaders, 26", on cats.
1—Goodman 665 Loader, on cats.
1—Goodman 660 Loader, on cats.
1—Goodman 460, rebuilt, on track.
2—Jeffrey 61 CLR's, on rubber, 26".
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1—200KW, G.E. HCC-6 Rotary Converter, 275 volt DC, newly rewound.
1—300KW, G. E. HCC-6 Rotary Conv., 275 DC.
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1—200KW MG Set, General Electric, perfect.
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2—300KW Westinghouse, 600 volt, 6 phase, Rotary Converters.
2—500KW Westinghouse, 600 volt, DC, 6 phase, Rotary Converters.
2—500KW HCC-6 Rotary Converters, 6 phase, 600 volt DC.
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1—GMC-671 Diesel with 75KW, 250 volt DC Generator.
1—GMC-671 Diesel with 110KW, 250 volt DC Generator.
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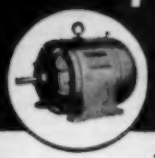

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40	Century B.B.Drip-Now DN-375		1800
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2—200 KW G.E. HCC6 Form P 1200 RPM
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TRACKLESS EQUIPMENT

3—Long 88 Pig Loaders
2—joBU-3E Joy Loaders, 250 V. D.C.
2—14BU-3PE Joy Loaders
7—14BU-2E Joy Loaders, 230 V. D.C., 28" DH
3—12BU-8E Joy Loaders
2—12BU-7E Joy Loaders
1—8BU Joy Loader, Rebuilt
3—8BU Joy Loaders, 220 V. A.C.
1—Lee Norse Continuous Miner
2—Myers Whaley, #88 Loaders
1—360 Goodman Loader on Rubber
1—8SC Shuttle Car, Elevating Discharge
4—6SC, 5E and 5EX Joy Shuttle Cars, matched pairs, disc brakes, elevating discharge
7—6SC-3CE Joy Shuttle Cars
1—5SC-7BXE Joy Shuttle Car
3—5SC Joy Shuttle Cars, Elevating Discharge
2—5SC Joy Shuttle Cars, Matched pair
1—32D Joy Shuttle Car
2—32E7 Joy Shuttle Cars
3—32E10 Joy Shuttle Cars, Rebuilt
1—32E16X Joy Shuttle Car, Rebuilt
7—42E13 Joy Shuttle Cars, Matched Pairs
2—42E7 Joy Shuttle Cars
2—T1 Joy Cat Trucks AC
2—T2-2E Joy Cat Trucks
1—T2-5E Joy Cat Truck
5—PL11-7PE and 8PE Joy Elevators
2—Acme Self-Propelled, 40 h.p. Air Compressors, Permissible
1—50 h.p. Acme, 210 CFM Compressor
1—WK29 Sullivan Air Compressor
1—340 cu. ft. WK-83 Joy Compressors, rubber mounted, self-propelled, 30" O.H., Excellent
1—210 cu. ft. Acme Compressor, on rubber
2—125 cu. ft. WL-82 Sullivan Compressors, rubber mounted and self-propelled
3—Joy T12 Supply Jeeps, Battery Complete w/Batteries and Chargers
2—MSA Bantam Rock Dusters on tires
1—Fletcher Roof Bolting Machine Sliding Head
1—CD25 Joy Coal Drill, Perfect
9—Manson Jeeps with 9J Motors
1—Lot Joy Motors and Armatures, 9J, 24J, 38J, Etc.

CONVEYORS

953'—48" Belt Conveyor, Complete
1,072'—648 Jeffrey, 36" Belt Conveyor Structure
1,000'—36" Joy Belt Conveyor
1,350'—36" Joy Model C, underground Belt Conveyor
8 36" Joy Belt Drives
1—36" x 150' Belt Conveyor
3—97HC 30" Tandem Belt Heads, 30 h.p. Drive
2—MTB Joy Tandem, 30" Belt Conveyor Drives, 25 h.p.
2,500'—30" Jeffrey 52B Structure
675'—30" Barber Greene Structure
2—30" Belt Conveyor Drives, shop constructed w/15 h.p. Motor and Controls
4—40 h.p. 90-5GT 30" Goodman Belt Conveyors, 1,000' centers, complete
2—40 h.p. 90-5GT 30" Belt Conveyor Drives
1—Jeffrey 52B 26" Belt Conveyor, 1,000' centers, complete
19,424'—26" Joy Belt Conveyor, Model C
2,450'—26" Joy MTB Belt Conveyor
17—26" Belt Drives of various types
360'—24" Goodman Belt Conveyor, complete
1—20" Joy Chain Conveyors, Permissible
10—15" Long Chain Conveyors, 350' centers complete w/400 DBH Long mobile head drive, 25 h.p. Motor, 230 V. D.C., cat mounted
4—15" Joy Chain Conveyors, Permissible
23—12" & 12" 61FW, 61HG, 61W and 61AM Jeffrey Chain Conveyors
7—G12½ Goodman Shakers, complete w/10' x 1½ pans
15—G12½, G15 and G20 Goodman Shakers
29—Goodman Power Duckbills, Model 477
2—PT12 Long Piggyback Conveyors
2—PT15 Long Piggyback Conveyors
10—PT15-B Long Piggybacks with 5 h.p. 230 V. Motors

SUBSTATIONS AND TRANSFORMERS

1—500KW G.E., MG Set
5—300KW MG Sets
2—200KW MG Sets
1—150KW G. E. Rotary Converter, w/Transformers
2—150KW Rotary Converters, Completely Automatic
15—150KW MG Sets of various makes and primary voltages
1—100KW Motor Generator Set
1—100KVA Gasoline Generator Unit
2—50KW, MG Sets, 125 V., D.C., 1200 rpm
2—Armatures for 150 and 200KW Rotary
2—600 & 800 Auto Transformers
138—Transformers from 5KVA to 500KVA

CUTTING MACHINES

1—824 Goodman Slabber
5—7AU Sullivans
5—7B Sullivans
17—11B Sullivans, 35 & 50 h.p.
15—12AB & 12AA Standard Goodmans
1—112AA Universal Goodmans
6—212AA Baby Goodmans, 250 Volt
3—612 Goodman Cutting Machines, 220 V. A.C.
8—312 and 712 Goodmans, w/Bugdusters
1—29U Jeffrey, 250 Volt
1—29U Jeffrey, 220/440 Volt, A.C.
3—35L Jeffrey Cutting Machines
52—35B & 35BB Jeffreys, A.C. & D.C. Bugdusters and Trucks available

LOCOMOTIVES

2—20 Ton MH77 Jeffreys, 42" t.g.
1—15 Ton HM82S G.E. Locomotive, 90 h.p. units, 44" O.H., 48" t.g., Excellent
8—13 Ton Locomotives, 250 V., Any gauge
1—12 Ton 29B Goodman Locomotive, 40" O.H.
5—10 Ton Locomotives, 250 Volt, any gauge
15—8 Ton Locomotive, 250 Volt, any gauge
8—7 Ton Atlas Battery Locomotives
1—6 Ton Battery Locomotive—NEW
27—6 Ton Locomotives, any gauge
3—6 Ton Jeffrey, MH150 Locomotives
12—6 Ton MH88 Jeffrey Locomotives
10—5 Ton Locomotives, 250 Volt
23—4 Ton Locomotives, 250 V., any gauge
1—4 Ton G. E. Battery Locomotive
1—4 Ton Mancha Battery Locomotive Spare Armatures and Trucks for most of above Locomotives

TIPPLE EQUIPMENT

1—4 Cell Jeffrey Baum Jig Washer, complete
1—CMI Coal Dryer, 48" Excellent
1—Heat Dryer, Complete
1—Marion Double Roll Primary Crusher
1—24" x 30" Pa. Single Roll Crusher
2—24" x 24" Jeffrey Single Roll Crushers
1—4' x 12' Double Deck Vibrator
1—3' x 6' Low Head Vibrator
5—Jeffrey Traylor Vibrator Feeders
4—Jeffrey Traylor Vibrator Screens
1—Magnetic Separator, Complete
1—Set Jeffrey Dewatering Screens
5—Stranor Conveyors of various sizes
10—Tipple Belts from 15" to 42" width
1—36" x 42" Loading Boom
Air Valves, Blowers, Pumps, New Screens, Parts for CMI Dryers, Speed Reducers, Feeders, practically Jeffrey Baum Jig in parts and many others parts for Tipple

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121—30" t.g. Drop Bottom Cars
249—42" t.g. End Dump Cars, various makes
22—42" t.g. ACF 6 Ton drop bottom Cars
22—44" t.g. Drop Bottom Cars, 10 ton
148—44" t.g. Drop Bottom Cars, various sizes
334—44" t.g. End Dump Cars, various sizes
305—48" t.g. S. D. Drop Bottom Cars, 22" O.H.
2—36½" t.g., 3 Ton, 4 Wheel Push Trucks

RAIL AND WIRE

816—Tons 30, 40, 56, 65 & 70 lb. Relaying Rail
4,200'—1,000,000 CM Feeder Cable, Insulated
1,518'—750,000 CM Insulated Copper Feeder Wire
3,197'—750,000 CM Bare Copper Feeder Wire
2,474'—350,000 CM Insulated Copper Feeder Wire
345'—300,000 CM Insulated Copper Feeder Wire
500'—4/0 Stranded Insulated Copper
17,757'—4/0 Trolley Wire
7,038'—6/0 Trolley Wire
1,250'—0 Section Trolley Wire
70,444'—4/0 Stranded Highline Wire
17,031'—2/0 Stranded Highline Wire
78,370'—1/0 Solid Copper Trans. Line
42,926'—#2 Stranded Transmission Wire
10,082'—#6 Solid Copper Transmission Wire
3,980'—4/0, 3 Cond. Neoprene Covered Cable
950'—2/0, 3 Cond. Ankydrox & Lead Covered Cable

MISCELLANEOUS

1—Canton Track Cleaner—Excellent
5—HKL Brown Fayro Car Spotters
7—CH Sullivan 5 h.p. Car Spotters
1—HKG Brownie Layer Leader Hoist
88—Hoists from 5 h.p. to 800 h.p.
6—Shop Constructed Jeeps, track mounted
588—Stationary Motors: ½ to 800 h.p. of various Specifications
1—Prefab Building, 40' x 84'
1—Prefab Building, 12' x 120'
104—Pumps from ¾" to 4500 GPM of various specifications
1—10 h.p. Deming Deep Well Pump
1—330 GPM, 6" POMONA Deep Well Pump
1—14" Centrifugal Slurry Pump, w/15 h.p. Motor
3,318'—¾" Galvanized Pipe
903'—1½" Black Pipe
1,000'—2" Plastic Pipe
25,765'—2" Black Pipe
500'—4" Black Pipe
47—Room Blowers; Brown Fayro & Jeffrey
39—Mine Fans from 30" to 6' Hi Pressure
97—Coal Drills, 571CP, 572CP, 573CP, 473CP, A6 and A7
1—WK29 Sullivan Air Compressor, 120 cu. ft. capacity, 48" t.g.
2—Cantrell Compressors, 120 cu. ft. capacity 48" t.g.
15—Battery Chargers, various voltages
6—Cleveland Sheers
15—Scales for Mine Tracks
22—Air Compressors of various sizes
9—Rock Dusters up to 30 h.p., track and rubber mounted
985—Edison Lamps, Model P and R4
57—Auto Starters from 3 h.p. to 100 h.p.
1—Dust Collector for Roof Bolting
22—18" x 24" I Beams
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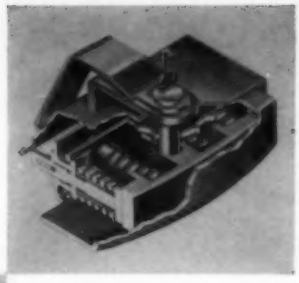

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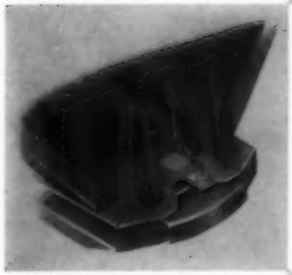

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A Report on Clinchfield's Moss Mine #3

smooth route for raw coal

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Designed, equipped and erected by Link-Belt under a single contract, this plant loads out metallurgical and steam coal at 1000 tph. Sixteen men per shift do it all—including maintenance.

The mine itself is located seven miles from the plant. R.O.M. coal is delivered by rail to the Link-Belt car dumping station and progresses through the sequence described at right.

A dramatic film documentary of this installation—"Preparation Makes the Product"—is available free for viewing by your group. Call your Link-Belt office to reserve it. Ask, too, for Book 2655 describing our complete line of coal preparation equipment.

15,197

1 Twenty-two 70-ton cars are unloaded every hour. Operator at control panel regulates dump cycle and dispatches cars to desired loading track.

2 Crushed raw coal flows on a 60-in. plant feed belt conveyor to 200-ton surge bin and via transfer belt conveyor to 600-ton surge bin, both at top of plant.

3 At crushing station, R.O.M. coal with lumps up to 3 ft. is reduced to minus 4-in. by crusher. It then travels by 60-in. belt conveyor to 2500 ton storage bin.

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